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in Russian Vol 27, No 6, Nov-Dec 86 (manuscript received 1 Aug 85) pp 43-48

[Article by V. V. Krylov, Ye. P. Ponomarev and T. V. Shtentsel, Department of Acoustics]

[Abstract] Thermooptical sound excitation in a metal is analyzed theoretically, metals being characterized by strong absorption of light and high thermal conductivity. An intensity-modulated plane laser beam is assumed to impinge normally on the surface, free boundary, of an elastically isotropic metal body appearing as a half-space relative to the laser beam width. All components of the displacement vector for acoustic waves excited as a result must satisfy the corresponding equation of mechanical motion, which relates components of this vector to components of the stress tensor through density of the metal, as well as the equation of state including thermal effects. The latter equation is linearized, as is also the equation of heat balance completing formulation of the problem. Viscosity effects are disregarded in the heat balance, inasmuch as they are very weak, and the small dilation term representing thermoelastic sound absorption is omitted from the equation of heat balance. In this approximation the heat balance equation becomes independent of the acoustic variables and can be solved separately from the other two equations. For purposes of this analysis, it is sufficient to solve it only for the two extreme cases of very large and very small ratios of light penetration depth to heat wavelength in the metal. The acoustic part of this boundary-value problem of sound excitation by laser radiation is solved with the aid of the corresponding Green tensor. This has been done for various ratios of characteristic laser beam width to wavelength of excited sound. In the one-dimensional case a very wide laser beam is found to excite in a metal only longitudinal sound waves propagating then through the metal, just as through a liquid, normally to its surface. The theoretical results agree closely with available experimental data, some discrepancies being attributable to cylindrical symmetry and a usually chopped profile of a real laser beam. Figures 3; references 15: 10 Russian, 5 Western.

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APPROXIMATION OF NONCORRELATED REFLECTIONS IN PROBLEM OF SOUND PROPAGATION THROUGH WAVEGUIDE WITH ROUGH BOUNDARY

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 17 Mar 86) pp 19-30

[Article by A. G. Voronovich, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences]

[Abstract] The problem of sound propagation through an oceanic waveguide with a rough turbulent water surface as upper boundary is considered, assuming that successive reflections of acoustic waves by that surface are statistically independent. Statistical characteristics of the acoustic field in such a waveguide are calculated, in the approximation of a horizontally homogeneous waveguide medium and a statistically uniform scattering surface. The correlation function for the acoustic field is found as the solution to the applicable integral equation, which reduces to the corresponding equation of radiation transfer. Attenuation and noncoherence as well as nonuniform waves and bottom effect are taken into account. The problem is solved for large-scale surface roughness, and the noncoherent component of the correlation function is determined for the case of a point sound source. The author thanks B. I. Klyachin for helpful discussions. Figures 1; references 14: 12 Russian, 2 Western.

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BEHAVIOR OF GASEOUS BUBBLE CLUSTER IN LIQUID IN FIELD OF ACOUSTIC PRESSURE WAVE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 10 Feb 86) pp 31-36

[Article by S. T. Zavtrak, Scientific Research Institute of Application Problems in Physics imeni A. N. Sevchenko, Belorussian State University imeni V. I. Lenin]

[Abstract] Interaction of a gaseous bubble cluster with a liquid in an acoustic field is analyzed, taking into consideration the radiation pressure force and the Bjerknes force with attendant redistribution of the gaseous phase and merger of bubbles in the liquid as well as the viscous resistance force. Calculations are based on the phenomenological model of a spherical bubble, its growth and monopole vibrations, with sound propagating through a liquid which contains such bubbles. Collisions between bubbles, buoyance of small bubbles, and resistance to bubble growth are disregarded, assuming that the attendant forces are negligible in comparison with the other three. Small values of the

Reynolds number correspond to Stokes laminar flow. The problem is solved for a cluster with linear dimensions much smaller than the wavelength of sound inside as well as outside it, a solution being obtained for a plane harmonic sound wave when all bubbles in the cluster are of the same size. It is then solved for a more probable cluster with bubbles of various sizes spread over some finite range, and finally for a cluster with linear dimensions comparable to or equal to the wavelength of sound. The results are applicable to ultrasonic cleaning with a self-clearing effect. The author thanks A. V. Prokurov. References 13: 11 Russian, 2 Western (both in Russian translation).

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MODE PATTERN OF FIELD GENERATED BY PARAMETRIC RADIATOR IN ACOUSTIC WAVEGUIDE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 13 Mar 86) pp 37-42

[Article by V. Yu. Zaytsev, L. A. Ostrovskiy and A. M. Sumin, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] In connection with the use of parametric radiators for oceanographic research, the field which such a radiator generates in an acoustic waveguide is analyzed for its mode structure and angular distribution pattern. The sound beam emitted by a directional radiator at an arbitrary angle to the waveguide axis is, except when parallel to the waveguide axis, subject to multiple reflection alternately by the waveguide top and bottom boundaries. The simplest and most practical case is that of a shallow sea, its free surface constituting an acoustically soft boundary and its bed constituting an acoustically stiff one. The corresponding nonhomogeneous wave equation is solved for a a low-frequency field in the far field, where the structure of such a field has been completely developed, for which case the triple integral of the Green function over the volume occupied by the pumping sound beam can be evaluated analytically. The characteristic width of that sound beam is assumed to be much smaller than the vertical mode scale and the phase of vertical low-frequency sources is assumed to change much less than 180° in any of its vertical sections. A solution is obtained for the general case of an arbitrary entrance angle and for the special case of an entrance angle equal to the inclination angle of Brillouin waves, in which case modes of the corresponding order are most efficiently excited. Figures 4; references 10: 7 Russian, 3 Western (1 in Russian translation).

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NOISE FIELD GENERATED BY SURFACE SOURCES IN COASTAL WEDGE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 7 Apr 86) pp 43-48

[Article by N. N. Komissarova, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] The problem of a noise field in a coastal wedge is treated in the geometric optics approximation, specifically for a wedge of a homogeneous medium on a half-space bed where the reflection coefficient depends on the glide angle of the incident sound wave. An array of noncorrelated noise sources with a radiation pattern that may be described by an energy distribution $G^2(\gamma_0) = \sin^{2m}\gamma_0$ (γ_0-wave glide angle at the surface, m = 1,2,...) is uniformly distributed on the free surface of this wedge. The problem is solved in an appropriate system of cylindrical coordinates, taking into account the anisotropy of surface noise at any point within the wedge. Analysis and calculations reveal that the noise field is strongly anisotropic in both vertical and horizontal planes, its pattern generally differing from that in a plane-parallel waveguide under similar conditions. The maximum noise intensity is in the direction from the edge (shore line) when the effect of multiple reflection is weak or in the direction corresponding to the critical glide angle when the effect of multiple reflection is strong. The noise intensity is zero in directions from the deep-water side of the wedge within some angle depending neither on the reflection coefficient nor on the width of the radiation pattern. Figures 4; references 7: 6 Russian, 1 Western.

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PERFORMANCE OF LINEAR VERTICAL ANTENNA IN REFRACTIVE MULTIMODE WAVEGUIDE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 23 Dec 85) pp 49-54

[Article by Yu. A. Kravtsov and V. M. Kuzkin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Excitation of normal waves by a linear vertical antenna in a horizontal refractive plane-multilayer waveguide such as an oceanic acoustical one is analyzed on the basis of the earlier obtained solution to the problem of an antenna radiating into a refractive multimode waveguide. Ignoring amplitude distortions and including only quadratic phase distortions caused by nonhomogeneity of the medium, the response pattern of such an antenna without compensation is calculated for the simplest case of a uniform amplitude distribution.

The response pattern simulated by the envelope of responses discretely calculated corresponding to various glide angles is found not to coincide with the radiation pattern, with the ratio of receiver gain to transmitter gain varying as a nonmonotonic function of the glide angle differently for different modes. This result implies that extending the range of sound propagation through seabed waveguides requires decreasing the fluctuations of the signal to be received by a long antenna. Figures 3; references 6: 4 Russian, 2 Western (both in Russian translation).

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ACOUSTIC FIELD IN WAVEGUIDE WITH SLOPING BED

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 6 Jan 86) pp 55-59

[Article by V. M. Kudryashov, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] The acoustic field in a waveguide nonuniformly deep because of a sloping bed is evaluated by a variant of the method of normal modes. The waveguide is treated as a two-layer medium with acoustically soft both free surface and bed, the latter having a ladder profile. The corresponding boundary-value problem is formulated in an appropriate Cartesian system of coordinates, for a monochromatic sound source and a field satisfying the Helmholtz equation. The system of eigenfunctions in this problem is found to be complete and orthogonal, whereupon the field distribution is calculated in the adiabatic approximation. The results yield a sound propagation anomaly, with scattering of normal waves at steps of the waveguide bed, this anomaly as well as the scattering coefficient being functions of the distance from the sound source. The algorithms have been programmed in FORTRAN for a BESM-6 high-speed computer. Figures 4; references 7: 4 Russian, 3 Western (1 in Russian translation).

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DIFFRACTION OF SOUND AT JUNCTION OF TWO WAVEGUIDES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 6 Jan 86) pp 66-71

[Article by L. A. Levitskiy, Leningrad Secondary School of Military-Engineering Construction imeni A. N. Komarovskiy]

[Abstract] Diffraction of sound at the junction of two horizontal identically wide waveguides in an acoustic medium is treated as a boundary-contact problem. The resulting sound pressure distribution, which must satisfy the homogeneous Helmholtz equation, is sought for the case of a right-hand waveguide with incompressible walls whose flexural vibrations are describable by the Kirchhoff equation for thin plates and a left-hand waveguide with walls satisfying the Neumann boundary condition. The excitation coefficients for normal modes in the left-hand waveguide and the reflection coefficient at the junction are calculated as functions of the wave number, these coefficients and the radiation pattern being interrelated through the law of energy conservation. Figures 4; tables 1; references 8: 7 Russian, 1 Western (in Russian translation).

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UTILIZATION OF SELF-REPRODUCTION PHENOMENON FOR MEASUREMENTS YIELDING SHAPE DYNAMICS OF PERTURBED LIQUID-GAS INTERFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 25 Apr 86) pp 93-96

[Article by A. M. Andreyev, V. M. Ginzburg, Yu. P. Presnikov and N. M. Ramishvili, All-Union Scientific Research Institute of Opticophysical Measurements]

[Abstract] An optical method which utilizes the self-reproduction phenomenon is proposed for determining the shape of liquid-gas interfaces during perturbation of the latter, whatever the cause of perturbation may be. This phenomenon, related to the Talbor effect, is that a laser beam illuminating a transparency with an image of a grating produces without the aid of any auxiliary optics sharp undistorted successive images of the grating at a distance and its multiples determined by the ratio of grating parameter to the squared laser wavelength. The method is applicable to acoustic interference holography of gibbous interfaces, a one-dimensional grating being adequate for a symmetric peak and high-speed photography being helpful in the case of a dynamic interface. The method was used experimentally with a two-dimensional grating for a liquid-gas interface with an asymmetric hump under perturbing ultrasonic radiation pressure. Figures 3; references 4: 2 Russian, 2 Western.

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SCATTERING OF SOUND BY REMOTE SEABED SEGMENTS DURING HORIZONTAL OCEAN PROBING

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 25 Mar 86) pp 96-98

[Article by M. Yu. Andreyev, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Scattering of sound by the seabed during horizontal probing of high seas up to 4.8 km deep has been evaluated on the basis of experimental field studies in the tropical zone in 1982 and in 1984, including measurements with 0.6-3.5 kHz signals and antennas up to 200 m deep. An analysis of echo signals with the aid of computer experiments reveals a variation of their intensity and delay as functions of time, the pattern of this variation being different in different azimuthal directions. These patterns reflect the seabed profile, indicating its peaks, slopes, and shelves. Scattering of sound by the seabed has been found to vary in intensity depending on the region and to be strongly anisotropic, in some locations not occurring at all. The author thanks I. B. Andreyev for helpful discussions. Figures 3; references 4: all Russian.

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NUMERICAL SIMULATION OF LOW-FREQUENCY ACOUSTIC NOISE IN STRATIFIED OCEAN

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 12 Jul 85) pp 113-116

[Article by O. E. Gulin, Pacific Institute of Oceanology, Far Eastern Science Center, USSR Academy of Sciences]

[Abstract] Propagation of low-frequency acoustic noise through a stratified and thus nonhomogeneous oceanic sound channel is considered, noise in the 1-10 Hz frequency band being typically generated by fluctuations of atmospheric pressure. For an analysis of this problem and the design of experiments, the space-time spectrum of such a noise was simulated numerically on the basis of applicable integral relations. With isotropic pressure fluctuations treated as Gaussian sources of surface noise and the depth coordinate normalized to the corresponding wavelength, the mean noise field intensity has been calculated as a function of the depth at the two corner frequencies of 1 Hz and 10 Hz. Calculations made without and with reflection by the seabed taken into account reveal the effect of a reflecting seabed. From the time spectra which the results of these calculations essentially represent have been extracted the uniform component of each, this component being of principal concern in oceanographic measurements. Figures 4; references 6: all Russian.

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DEPENDENCE OF MODE ATTENUATION COEFFICIENTS ON PARAMETERS OF HYDROACOUSTIC WAVEGUIDE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87 (manuscript received 21 Apr 86) pp 132-134

[Article by A. N. Kovalev, Ye. A. Rivelis and S. L. Edelshteyn; Computer Center, Rostov State University imeni M. A. Suslov]

[Abstract] Exponential attenuation in addition to cylindrical half-power attenuation of normal modes propagating through a hydroacoustic waveguide and its dependence on the waveguide parameters (density, acoustic velocities, acoustic absorption coefficient) is considered, specifically in a waveguide consisting of a depthwise nonhomogeneous water layer under a thin ice crust. The corresponding Sturm-Liouville eigenvalue problem of spectral analysis, in the approximation of small imaginary components of the wave numbers, is solved by the vector version of the perturbation method. Solution of the problem requires evaluation of four characteristic coefficients, which can be done by the Wentzel-Kramers-Brillouin method for the surface channel with ice and for the bottom channel bordering on the bed. Figures 1; references 11: 8 Russian, 3 Western (2 in Russian translation).

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REFLECTION COEFFICIENT FOR RAYLEIGH WAVE AT EDGE OF OBTUSE WEDGE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87 (manuscript received 31 Oct 85) pp 138-140

[Article by V. V. Krylov, Department of Physics, Moscow State University imeni M. V. Lomonosov]

[Abstract] A new variant of the perturbation theory is proposed for analysis of scattering of Rayleigh waves in an obtuse wedge by its edge and for calculation of the corresponding reflection coefficient. According to this "rounding" method, the wedge is mounted on the lateral surface of an inscribing circular cylinder with a radius much larger than the reciprocal of the wave number so that to a Rayleigh wave propagating on the cylinder surface in any direction this surface appears, in the first approximation, as a plane one and the edge of the wedge constitutes a perturbation normal to the surface. The equivalent problem can be solved for any incidence angle of a Rayleigh wave. The reflection coefficient does not depend on the wave frequency but only on the wave incidence angle, the wedge angle, and the Poisson ratio of the wedge material. It is calculated here first analytically for the general case of an

obliquely incident Rayleigh wave, then also numerically for two aluminum wedges with 160° and 140° angle respectively. A comparison with experimental data based on measurements at a frequency of 2.1 MHz with pulses of 5 μs duration indicates a close quantitative agreement for the wedge with a 160° angle and only a qualitative agreement for the wedge with a 140° angle. Figures 2; references 9: 5 Russian, 4 Western.

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FIELD OF SPHERICAL FOCUSING TRANSDUCER WITH ARBITRARY APERTURE ANGLE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 10 Mar 86) pp 140-143

[Article by V. M. Levin, O. I. Lobkis and R. G. Mayev, Institute of Chemical Physics, USSR Academy of Sciences]

[Abstract] The field of a spherical focusing acoustic transducer with an arbitrarily large aperture angle is analyzed by the O'Neyl method of mapping the boundary conditions onto a plane and is evaluated by integration over a plane surface. A cylindrical system of coordinates is introduced with the origin at the center of the transducer surface, its z-axis coinciding with the acoustic axis passing symmetrically through the aperture and its r-axis in the plane tangent to the sphere. The first boundary-value problem for the Helmholtz equation in this system of coordinates is solved for the equivalent plane transducer with a characteristic linear dimension larger than the wavelength of sound in the transducer medium. The authors thank I. N. Kanevskiy for helpful discussion. Figures 1; references 6: 1 Russian, 5 Western (1 in Russian translation).

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SCATTERING OF LONGITUDINAL WAVE NORMALLY INCIDENT ON DISCAL CAVITY IN ELASTIC BODY

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 30 Apr 85, after correction 5 Jun 86) pp 143-148

[Article by S. V. Martynenko, Moscow Higher Technical School imeni N. E. Bauman]

[Abstract] Scattering of a longitudinal plane monochromatic elastic wave inside an infinitely large isotropic body by an infinitesimally thin internal crack or cavity of discal shape is analyzed as a problem of ultrasonic flaw

detection. Normal incidence and the frequency range covering successive resonances are considered, with the disc accordingly oriented at right angles to the incident wave and its radius being much larger than the wavelength. The corresponding Helmholtz equation is solved by the Fourier method, for a homoegeneous isotropic medium where the equation $\rho(\partial^2 u/\partial t^2) = (\lambda + 2\mu)$ grad div u - μ curl curl u applies (ρ - density of medium, u - displacement vector, t - time, λ,μ - Lamé parameters). The solution is obtained in series, in a form reducible to two systems of linear algebraic equations for odd and even coefficients respectively so as to be convenient for computer-aided numerical evaluation. On the basis of this solution the scattering pattern and the dependence of its maximum on the wave dimension of the discal scatterer has been calculated. Figures 3; tables 1; references 13: 6 Russian, 7 Western (3 in Russian translation).

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EQUATION OF ACOUSTIC AND GRAVITATIONAL WAVES IN STRATIFIED MOVING MEDIUM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87 (manuscript received 15 Nov 85) pp 150-152

[Article by V. Ye. Ostashev, Institute of Atmospheric Physics, USSR Academy of Sciences]

[Abstract] A single closed equation is derived to describe both acoustic and gravitational waves in a stratified moving medium, with compressibility of the medium and buoyancy taken into account. This equation, a partial second-order differential with respect to the longitudinal coordinate but of sixth order with respect to time and radial coordinate, follows as an exact corollary from the linearized system of equations of hydrodynamics for such a medium. The coefficients in this equation are functions of the longitudinal coordinate only and, therefore, express the vibrational component of pressure in the form of a Fourier integral with respect to time and the radial coordinate will reduce this equation to a one-dimensional ordinary second-order differential (Helmholtz) equation. References 6: 5 Russian, 1 Western (in Russian translation).

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DYNAMICS OF ELECTROACOUSTIC ECHO IN SEMICONDUCTOR STRUCTURE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 24 Apr 86) pp 155-157

[Article by F. M. Severin, L. A. Slavutskiy, and G. Yu. Timofeyev, Department of Physics, Moscow State University imeni M. V. Lomonosov]

[Abstract] A comparative study of two-pulse and three-pulse echos on surface acoustic waves in piezoelectric-semiconductor structures is reported, involving evaluation of experimental data and theoretical calculations. The experiment was performed with a YZ-$LiNbO_3$ - Si structure and two interdigital electroacoustic transducers operating with 15 V transverse electric excitation at a frequency of 60 MHz. Forward surface acoustic waves were transmitted by one transducer and echo signals were received by the other. The piezoelectric substrate and the semiconductor layer were respectively 1.5 mm and 0.5 mm thick, the Si layer having an electrical resistivity of 5 ohm·cm. Surface acoustic pulses of 2 μs duration were transmitted in 10 μs and 100 μs intervals. Electroacoustic interaction was monitored under conditions of resonance, with the frequency of surface acoustic waves also 60 MHz. Theoretical analysis was based on the quasi-static model of an electroacoustic echo on surface acoustic waves of arbitrary amplitude. Calculations have yielded the dependence of the ratio of three-pulse echo amplitude to two-pulse echo amplitude on the SAW power, also of the characteristic relaxation time for a charge lattice on Si surface states on the SAW power. Figures 2; references 9: 7 Russian, 2 Western.

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EXPERIMENTAL STUDY OF STIMULATED RAMAN SCATTERING OF SOUND BY GAS BUBBLES IN WATER

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 1, Jan-Feb 87
(manuscript received 25 Sep 86) pp 163-164

[Article by O. Ya. Butkovskiy, Ye. A. Zabolotskaya, Yu. A. Kravtsov and V. V. Ryabykin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] An experiment has confirmed the theoretically established possibility of stimulated Raman scattering of sound by gas bubbles in a liquid, interaction of the pumping wave (frequency ω_p) and the natural vibrations of bubbles (frequency ω_0) resulting in amplification of the difference-frequency ($\omega_p - \omega_0$) wave. The experiment was performed in a water tank 1200 mm high and 400x400 mm^2

in cross-section, bubbles being generated in it by electrolysis. A monochromatic pumping signal was generated by a piezoceramic radiator. This signal passed twice through a bubble layer 250x360 mm^2 in cross-section, the second time after reflection by a tank wall. Two hydrophones were used, one for recording the main scattered signal in the direction of the pumping signal and one for recording the quadrature scattered signal. The main signal, after amplification, was detected for processing by a spectrum analyzer and the output data were recorded by a magnetophone for processing on a computer. The size fraction of bubbles was determined on the basis of linear sound attenuation, the maximum size being $R \sim 0.06$ mm ($f = 55$ kHz) with a standard deviation $\Delta R = 0.04$ mm ($\Delta f = 30$ kHz) at a current density of 0.8 mA/cm^2. Deflection of bubbles from the high-intensity region of the pump field prevented recording the dependence of the Stokes component on the pump intensity and thus separating stimulated Raman scattering from attendant other effects. Figures 3; references 6: all Russian.

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METAL-OXIDE SUPERCONDUCTOR $BaPb_{1-x}Bi_xO_3$: UNUSUAL PROPERTIES AND NEW APPLICATIONS

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 150, No 4, Dec 86 pp 599-623

[Article by A. M. Gabovich and D. P. Moiseyev, Institute of Physics, UkSSR Academy of Sciences]

[Abstract] Since $BaPbO_3$-$BaBiO_3$ solid solutions with a perovskite structure had been produced in 1974, these complex oxides describable by the general formula $BaPb_{1-x}Bi_xO_3$ were studied extensively on account of their superconducting characteristics. Their unique properties include an anomalously low density of electron states on the Fermi surface and a metal→dielectric transition with attendant change of composition, such an oxide in ceramic form constituting a multiple Josephson medium. As a result of theoretical and experimental studies have been determined their crystalline structure and phase transitions. Measurements have revealed a composition dependence of the superconducting transition temperature with that temperature being highest for the oxide with $x = 0.25$ and dropping below 4.2 K for oxides with $x \leq 0.1$ or $x \geq 0.35$, also the temperature dependence of their electrical resistivity, and the composition dependence of the current carrier density at 77 K and at 300 K peaking for $x = 0.2$ at each temperature. Attempts have been made to raise the superconducting transition temperature of these oxides in either single crystal or film form. The macrostructure of these oxides in polycrystalline ceramic bulk form and film form was examined. Josephson effects in bulk and film specimens of polycrystalline ceramics have been established, with a dependence of the critical current on the magnetic field intensity and with a multistep current-voltage characteristic, transparence of thin films letting infrared light influence the latter. The thermodynamics and the electrodynamics of the superconducting state have been analyzed on the basis of theoretical relations and measurements. A correlation has been established between normal-state and superconducting-state properties which reveals the nature of superconductivity of these oxides. The simplicity of producing bulk specimens, ceramic or single crystals, with Josephson tunneling and symmetric potential barrier, provides a convenient model for study of various phenomena such as synchronization in disordered Josephson media, current transport by the percolation mechanism, and non-equilibrium effects in superconducting tunnel junctions with potential profiles of either the "multiple" ceramic kind or the "bicrystal" kind. A state of the art has already been reached which makes it feasible to build low-inertia high-sensitivity radiation detectors as well as multifunctional devices

on the basis of Ba-Pb-Bi oxides. The authors thank A. F. Prikhotko for support and attentiveness, A. S. Aleksandrov, V. F. Gantmakher, Yu. F. Revenko, M. N. Khlopkin, A. S. Shpigel for discussion of review items, and M. E. Raykh for providing useful information. Figures 15; references 213: 86 Russian, 127 Western (4 in Russian translation).

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CYCLOTRON-PHONON RESONANCE WITH PHONON ABSORPTION IN InSb

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 2, 25 Jan 87 (manuscript received 7 Dec 86) pp 104-106

[Article by O. M. Leshko and Ye. M. Sheregiy, Drogobych Pedagogical Institute imeni I. Franko]

[Abstract] An experimental study of cyclotron-phonon resonance in n-InSb was made, including measurement of photoconduction induced by radiation from a CO_2-laser in a pulsating magnetic field of up to 400 kOe intensity at temperatures covering the 77-160 K range. Specimens of the semiconductor material were placed in a cryostat, inside a solenoid generating magnetic field pulses of 4 ms duration. They were excited by an LG-705 laser through composite filters (especially built at the Central Design Office, BSSR Academy of Sciences) extracting radiation at either of two wavelengths, λ_1 = 10.62 μm or λ_2 = 9.57 μm, and a hollow Melchior tube with focon termination serving as light guide. A shutter with lobar diaphragm synchronized with the trigger of magnetic field pulses passed laser radiation only during those pulses. Photoconduction voltage signals were differentiated in an RC-circuit, their first derivative with respect to time was amplified, and their second derivative with respect to magnetic field intensity was recorded on an S8-13 memory oscillograph. Measurements have yielded the dependence of that second derivative on the magnetic field intensity over the 0-400 kOe range, at the two laser radiation wavelengths at various cryogenic temperatures, a typical n-InSb specimen having an electron concentration $n = 9 \cdot 10^{13}$ cm^{-3} and an electron mobility $\mu = 4.5 \cdot 10^5$ $cm^2/(V \cdot s)$. The results indicate that the condition $\hbar\omega = E_N - E_0 - \hbar\omega_{LO}$ for absorption resonance at radiation frequency ω is satisfied (E_N, E_0-Landau energy levels, ω_{LO}-frequency of longitudinal optical phonon). The authors thank I. B. Levinson for discussing experimental results and for valuable comments. Figures 2; references 9: 4 Russian, 5 Western (1 in Russian translation).

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SOME CHARACTERISTICS OF CHARGED STATES OF OXYGEN IN HIGH-RESISTIVITY GaAs

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 27, No 6, Nov-Dec 87 (manuscript received 11 Feb 86) pp 88-90

[Article by V. A. Morozova and V. V. Ostroborodova, Department of Semiconductor Physics]

[Abstract] An experimental study of high-resistivity GaAs(O) containing oxygen donors in As(O_{As}) nodes, with the donor level charged by electrons to various degrees, was made for a comparative evaluation of its dark-charge and photocharge parameters as well as optical absorption and photoconduction spectra relative to those of high-resistivity p-GaAs(Cr). Specimens with maximum resistivity ($2 \cdot 10^8$ ohm·cm) were tested, as were specimens with resistivity ranging from high (10^8 ohm·cm) to low (10^4 ohm·cm). The results of measurements, including the temperature dependence of the ionization energy for the oxygen donor level and the energy gap for GaAs over the 80-300 K range, together with the results of mass-spectral analysis for Cr and O^+ concentrations confirm the authors' earlier hypothesis that always present O^+ ions rather than Cr atoms in p-GaAs(Cr) determine the optical absorption in the $h\nu > 0.75$ eV energy range. The nature of oxygen donor centers and their role can be understood in the light of these results. Figures 3; references 11: 6 Russian, 5 Western.

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BLUE BAND LUMINESCENCE EXCITATION SPECTRA IN GALLIUM NITRIDE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86 (manuscript received 30 Jan 86) pp 1034-1036

[Article by M. D. Shagalov and A. G. Druzhuk]

[Abstract] The doping of gallium nitride with zinc and with zinc and oxygen causes the formation of two types of centers which have the same band (E_{max} = 2.6 eV) in luminescence spectra and can only be distinguished in GaN by means of polarization characteristics and spectral variations in relation to temperature. Blue photoluminescence in GaN-Zn is due to the recombination of conduction band electrons with acceptance band holes while photoluminescence excitation in GaN-Zn, GaN-O gives a nonpolarized blue band indicating that there are zinc centers not linked with oxygen. Another type of center appears with electro- and photoluminescence when the illumination is in the absorption range of the impurity and polarization can reach approximately 60%. It had

been established that an anisotropic oxygen-zinc complex accounted for the blue band in GaN-Zn, GaN-O but the supposition that generation of luminescence was due to transitions between two levels of the complex had not been investigated and experiments were carried out to compare spectra in GaN-Zn and GaN-Zn, GaN-O in order to determine the character of the transitions. Measurements were made of luminescence with $h\nu < 2.5$ eV by means of an MSD monochromator with a KGM-24-150 incandescent lamp as light source. The GaN-Zn spectrum peaks in the ultraviolet range and correlates with a secondary peak in the ultraviolet of the GaN-Zn, GaN-O (at approx. 3.29 eV) which has a primary and stronger peak in the electroluminescence excitation range of the impurities (approx. 2.8 eV). The GaN-Zn spectrum and the secondary peak of the GaN-Zn, GaN-O correlate with the spectrum of GaN. The data indicate that the main excitation band in the GaN-Zn, GaN-O is due to transitions which are not linked to the conduction band and that the band in the ultraviolet range is a distortion due to overlapping with the main region of GaN absorption. These results are supported by temperature variation experiments in the 80-300 K range. The general conclusion is that because of the formation of the oxygen-zinc complex in GaN at least two energy levels form in the GaN forbidden band and polarized blue luminescence arises in the GaN-Zn, GaN-O by electron transition from an upper to lower level. Figures 2; references: 6 Russian.

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MAGNETOOPTICAL STUDIES OF Nd^{3+} LEVELS IN DOUBLE POTASSIUM MOLYBDATES AND TUNGSTATES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86 (manuscript received 24 Feb 86) pp 1022-1024

[Article by I. S. Gorban, A. A. Pavlyuk, A. V. Slobodyanyuk and V. A. Shevchenko]

[Abstract] The Stark structure of the energy spectrum of Nd^{3+} as activator in potassium molybdates and tungstates has been studied in absorption and luminescence experiments but techniques using applied external fields are necessary for determining the internal crystal structure. Magnetooptical spectroscopy gives data on the activator, i.e., g-factors and transitions of optical states and is preferable to electron paramagnetic resonance spectroscopy because large concentrations of activator centers approximating to actual crystal aggregates can be studied. Magnetooptical research is described on $KY(MoO_4)_2$, $KY(WO_4)_2$, $KGd(WO_4)_2$ and $KLu(WO_4)_2$ crystals activated by Nd^{3+} ions in magnetic fields of up to 300 kG. Diagrams are shown of the splitting of the lines for energy levels in relation to the applied magnetic field with temperature lowered to 77 K. Comparison of the spectra showed that Nd^{3+} spectra were similar in the tungstates both with and without the magnetic field, Stark splitting differed

in the molybdates and tungstates while the character of the splitting in the magnetic field was the same for molybdates and tungstates so that Stark splitting is more sensitive to the crystal environment than are the Zeeman effects. This may be explained by wave functions for perturbed and unperturbed conditions and supporting experimental data is given for g-factor values for perturbed and unperturbed states of the Nd^{3+} activator. Figure 1; references 6: 4 Russian, 2 Western.

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INSTABILITY OF STRONG-ABSORPTION DOMAIN IN SEMICONDUCTOR

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 5 Dec 86) pp 142-144

[Article by V. A. Stadnik, Institute of Solid-State Physics, USSR Academy of Sciences]

[Abstract] Formation of moving strong-absorption domains in a homogeneous semiconductor by impinging laser radiation was demonstrated experimentally, a steep nonlinear increase of the absorption coefficient having been attained by the thermal mechanism. In the experiment ZnSe single crystals were used with an energy gap E_g = 2.68 eV at room temperature and an ILA-120 continuous-wave Ar-laser emitting $\hbar\nu$ = 2.54 eV energy quanta, excitation by quanta $\hbar\nu < E_g$ pulling the edge of the fundamental absorption band toward longer waves and switching segments of a crystal into the secondary state where $E_g > \hbar\nu$ with an attendant increase of the absorption coefficient by 2-3 orders of magnitude. The light intensity in a crystal was varied over the 10-100 kW/cm^2 range. Localized and moving domains of that kind were examined and recorded under an MBS-9 microscope in the luminescence mode, interband excitation of ZnSe occurring within them. The kinetics of light propagation through a crystal as well as the dependence of the domain thickness and the domain displacement on the intensity of incident light were measured, both having been found to increase as the light intensity increases with an attendant smooth transition from weak to strong pulsations. The dependence of the domain velocity on the light intensity was found to be a bifurcate one, with an unstable lower branch. In a homogeneous crystal, therefore, a domain can move under light of higher than critical intensity. At a sufficiently high light intensity, moreover, it can separate from the inhomogeneity in a crystal and move counter to the propagation of light. As critical light intensity is regarded that necessary to maintain uniform motion of a domain in a homogeneous crystal after it has formed at and departed from the back facet of the latter. The author thanks A. F. Dita (?), L. V. Keldysh, and V. B. Timofeyev for helpful discussion. Figures 2; references: 2 Russian.

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SCATTERING OF LIGHT DURING SURFACE MELTING OF DIPHENYL AND POSSIBILITY OF FORMING LIQUID-CRYSTAL SURFACE PHASE

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 20 Oct 86) pp 130-132

[Article by A. A. Chernov and V. A. Yakovlev, Institute of Crystallography, USSR Academy of Sciences]

[Abstract] An experiment with surface melting of diphenyl at its (001) and (010) facets with optical-grade finish along their contact with glass was performed, to determine the possibility of forming a liquid-crystal surface phase, at temperatures held constant within 0.01 K by a thermostat. The thickness of liquid films was measured with an ellipsometer accurately within ± 5 Å. The measurements have revealed a dependence of the film thickness on the degrees of supercooling below the corresponding surface melting point, a monotonic dependence describable by the equations $h_{001}(\text{Å}) = 73 - 28 \log\Delta T(K)$ for the more densely packed (001) facet and $h_{010}(\text{Å}) = 220 - 65 \log\Delta T(K)$ for the less densely packed (010) facet or by the relation $h \sim (\Delta T)^{-1/p}$ $(2.5 < p < 3.5)$ for both facets within the range of small supercooling. The intensity of light scattering by the two faces was found to peak sharply upon supercooling by $\Delta T = 0.3$ K and $\Delta T = 0.45$ K respectively. Figures 2; references 14: 6 Russian, 8 Western.

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NEW KIND OF EFFECT OF MAGNETIC FIELD ON STRUCTURAL PHASE TRANSITIONS: STIMULATED COOPERATIVE JAHN-TELLER EFFECT

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 12 Nov 86) pp 136-139

[Article by B. G. Vekhter, V. N. Golubev, and M. D. Kaplan, Institute of Chemistry, MSSR Academy of Sciences]

[Abstract] A new effect of a magnetic field on structural phase transitions in Jahn-Teller crystals such as tetragonal $Tb_xGd_{1-x}VO_4$ and virtually elastic $TmPO_4$ is demonstrated theoretically, namely retention of the phase transition and its stimulation over a wider temperature range within which the ordered phase will exist. The mechanism of this effect, shown to occur in a magnetic field parallel to [100], is explained on the basis of the microscopic theory in the approximation of a molecular field with a single-node Hamiltonian for four lowest states. An ion of a rare-earth element has three lowest levels quite far from its other excited states, and suppression of the structural phase transition or its enhancement with spread over the entire temperature range are known to occur in a magnetic field parallel to [001] or [110] respectively. The mechanism of the new effect is thus more intricate. Theoretical estimates for $Tb_{0.33}Gd_{0.67}VO_4$ pertaining to the dependence of its order

parameter on the magnetic field intensity at temperatures of 2.1-8.3 K and of its soft elasticity constant C_{66} on the temperature in magnetic fields of 0-10.7 kOe are readily verifiable by experiment. Figures 3; references 4: 1 Russian, 3 Western.

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INVERTED PERSISTENT OPTICAL ECHO IN CRYSTAL

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 3, 10 Feb 87 (manuscript received 4 Dec 86) pp 122-125

[Article by N. N. Akhmediyev, B. S. Borisov, V. A. Zuykov, V. V. Samartsev, M. F. Stelmakh, A. A. Fomichev, and M. A. Yakshin]

[Abstract] An inverted persistent laser echo signal in a $LaF_3:Pr^{3+}$ crystal with a "memory" much longer than the lifetime of the stimulated optical state was sought and recorded in an experiment with a LaF_3 crystal containing 0.5 atom.% Pr^{3+} ions resonantly excited at the $^3H_4$-$^3P_0$ energy transition at 4777 Å. A radiation pulse from a dye laser pumped by a YAG laser at a repetition rate of 12.5 Hz was focused on a 0.1 cm thick crystal inside a cryostat at a temperature within the 1.6-4.2 K range. A beam splitter diverted part of the radiation through two delay lines forming respectively a second pulse and then a third pulse for successive impingement on the crystal. The interval from second pulse to third pulse was varied from zero, simulating a two-pulse mode, to one by far exceeding the 50 μs lifetime of the upper optical state. The echo signal was transmitted through a semitransparent mirror, a lens, a diaphragm, and a set of light filters to a photoreceiver. Oscillograms revealed an inverted echo of up to 5 s duration in the two-pulse mode as well as in the three-pulse mode. Such a long optical "memory" is known to be associated with transfer of "information" about the "lattice" of the nonequilibrium difference of populations after first pulse and after second pulse, respectively, from optical sublevels to hyperfine sublevels of the $^3H_4$ ground state, uncontrollable inclusions such as Nd^{3+} ions inducing transitions between hyperfine sublevels and thus shortening the optical memory. The authors thank S. P. Chernov for supplying experimental crystals, I. Kh. Bikbov, L. I. Strelets, R. G. Usmanov, and I. Kh. Khadyyev for assisting in preparation and performance of the experiment. Figures 3; references 10: 4 Russian, 6 Western.

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HIGH-ENERGY 4f-STATES OF Er^{3+} AND Ho^{3+} IONS IN FLUORIDE CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 12 Mar 86) pp 464-466

[Article by L. I. Devyatkova, O. N. Ivanova, V. V. Mikhylin, S. N. Rudnev and S. P. Chernov]

[Abstract] Energy levels and wave functions of high-energy 4f-states as well as intensities of transitions have been calculated for Er^{3+} and Ho^{3+} ions in fluoride crystals, in accordance with the Judd-Ophelt theory and in the one-configuration approximation of the perturbation theory. A comparison of numerical results with experimental data indicates that the transition scheme unambiguously identifies the spectra of these ions within the vacuum-ultraviolet region. Tables 1; references 4: 2 Russian, 2 Western.

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NATURE OF INACTIVE ABSORPTION IN LiF CRYSTALS WITH F_2^- COLOR CENTERS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 14 Jul 86) pp 381-385

[Article by N. A. Asayenok, N. N. Vasilyev, Yu. I. Dudchik, A. P. Shkadarevich and Yu. A. Ekmanis]

[Abstract] Possible mechanisms of inactive radiation absorption in LiF crystals with impurity centers are considered, specifically in crystals containing not more than 10^{-3} mol.% cationic impurities and in amount of anionic impurities ensuring optimum laser characteristics of LiF with F_2^- - color centers induced by γ-radiation under optimum conditions. Analysis of the absorption process is based on experimental evidence such as absorption spectra measured over the 0.7-1.5 μm range of wavelengths at a temperature of 4.2 K. Thermal annealing of crystals at temperatures of 350-450 K was found to annihilate F_2^- centers and to increase the inactive-absorption index. Long irradiation of crystals with ultraviolet light was found to annihilate F_2^- and F_3^- centers. The experimental results can be explained on the premise that centers of inactive absorption are colloidal particles in the crystal. The authors thank V. P. Gapontsev for performing low-temperature measurements, V. I. Komarov for performing X-radiographical examinations, and A. V. Getkin for performing electron-microscopic examinations. Figures 2; tables 2; references 18: 17 Russian, 1 Western.

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EFFECT OF EXTRANEOUS FACTORS ON OPTICAL ONE-PHONON TRANSITIONS IN IMPURITY CENTERS WITH CUBIC SYMMETRY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 27 Jan 86) pp 372-380

[Article by V. I. Cherepanov, V. N. Frolov and A. N. Frolov]

[Abstract] The effect of extraneous factors, a uniform electric or magnetic or mechanical stress field, on optical one-phonon and nonphonon transitions in impurity centers with cubic point-group symmetry is evaluated by parametrization of the perturbation theory. This method facilitates calculation of the split of such transitions and the polarization dependence of the intensity of each component. It yields analytical relations which allow comparing calculated intervals between transition components with measured ones. Polarization characteristics of transitions calculated for $SrCl_2:Yb^{2+}$ and $SrF_2:Sm^{2+}$ are on this basis compared with measured ones, earlier experiments having already revealed a "heating" of one-phonon transitions in a magnetic field or under mechanical stress. Tables 4; references 11: 9 Russian, 2 Western.

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UDC 621.373:535+535.317.1

FORMATION OF HIGH-COHERENCE RADIATION IN FREE-RUNNING MODE RUBY LASER FOR PULSE HOLOGRAPHY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86
(manuscript received 19 Mar 86) pp 1090-1095

[Article by S. D. Nikolayev and I. O. Starobogatov]

[Abstract] Continuous helium-neon and ion lasers are now being used for high-quality holography but there are strict constraints as to lens and optical circuit stability. The use of pulsed lasers could eliminate these constraints and allow recording of moving objects. Pulsed free-lasing mode ruby lasers are the most promising for large format holography but previously the spatial coherence of the beam has not been sufficient and the cross-sectional energy distribution of the beam has shown a nonhomogeneous ring structure. Existing free-lasing mode ruby lasers have not attained the parameters required for large-scale pulse holography, i.e., pulse energy of 10 J, coherence length of 1 m, high spatial coherence and beam cross-section energy homogeneity. A laser design realized in a 1700 X 350 X 300 m^3 unit is described which has improved performance. It consists of a resonator containing an active ruby element 16 mm in diameter and 120 mm long with a pumping helium-neon laser connected to the resonator by a telescopic tract. The output pulse had an energy of 7-10 J and the pulse was 1.8 ms long and consisted of an aggregate of peaks 40 μs apart so that there were 40-50 per pulse. The beam with a 12 mm diameter has a homogeneous cross-sectional energy distribution but small-scale inhomogeneities were observed with dimensions of 0.1-0.2 mm and with energy fluctuations of 30-40% from the average which were due to bubbles in the ruby crystal. The spatial coherence function module was greater than 0.5. The stability of the wavelength ($\Delta\lambda/\lambda$) from peak to peak for a 30 min period was better than 4×10^{-7}. The volume of the scene which can be holographically recorded was superior to that of an earlier ruby laser device by a factor of 2 and attained 1 cubic meter. The high level of wavelength stability makes the design useful for the monitoring of large objects by two-pulse holographic interferometry methods while, because of the discrete time structure of the pulse with energy peaks of up to 0.2 J, the design could be used for the study of μs and ms dynamic processes. Figures 3; references: 10 Russian.

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MASSES OF VECTOR AND QUASI-SCALAR MESONS IN MODEL OF QUARK LOOPS

Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 60, No 1, Oct 86 (manuscript received 10 Nov 85) pp 156-160

[Article by M. K. Volkov and A. N. Ivanov, Joint Institute of Nuclear Research]

[Abstract] Masses of vector and pseudoscalar mesons are described and evaluated according to the model of quark loops, a correct complete description of these masses being possible with parameters related to the chopping momentum Λ and to the masses of constituent u-, d-, s- quarks. Into account are taken $\phi_i \leftrightarrow A_i$ transitions, occurring through the quark loop describable by a Lagrangian and necessary for correct description of the u-quark mass, as well as $\omega \to 2\pi$ decays. With those masses and the chopping momentum evaluated on this basis, it is possible to also determine the four-quark interaction constant and such fine effects as the difference between K^0-meson mass and K^+-meson mass or the relation between constants F_K and F_π. Figures 1; references references 12: 3 Russian, 9 Western.

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DISCUSSION ON POSSIBILITY OF BOOSTING NUCLEAR DECAYS IN STRONG ELECTROMAGNETIC FIELDS

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 2, Feb 87 (manuscript received 17 Jun 85) pp 357-359

[Article by I. M. Ternov, V. N. Rodionov, V. G. Zhuleto, O. S. Pavlova, A. Ye. Lobanov and O. F. Dorofeyev, Moscow State Jniversity]

[Abstract] The effect of an electromagnetic field on β-decay is discussed, the relative increase of the decay probability with decreasing energy release having been so far established in the nonrelativistic approximation only. Taking relativistic effect into account has yielded some corrections to the total probability of β-decay in the field of an electromagnetic wave. More corrections are added by taking into account polarization effects, polarization of reacting particles and polarization of the impinging electromagnetic wave. For a quantitative analysis of the corrections, the total correction to the

decay probability is expanded into a fourth-degree trinomial so that each correction can be evaluated, oscillating terms appearing in the most general case having no effect on the order of magnitude of corrections. In some cases the decay probability may depend on the parameters of the impinging electromagnetic field only and be independent of the energy release. In the case of a small energy release, however, it may depend also on the spin orientation of the original nucleus. Taking into account the anomalous magnetic moment of a decaying particle leads to further important consequences concerning the decays probability, the resulting correction becoming the principal one and depending linearly on the intensity of the external field. References 21: 18 Russian, 3 Western.

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EXCLUSIVE PRODUCTION OF PSEUDOSCALAR MESONS IN NEUTRAL CURRENTS BY SCATTERING OF NEUTRINO

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 2, Feb 87
(manuscript received 4 Feb 86) pp 467-477

[Article by Yu. Ya. Komachenko and M. Yu. Khlopov, Institute of High-Energy Physics, Serpukhov]

[Abstract] Considering that latest developments in physics of high-energy neutrino will facilitate a thorough study of exclusive $\nu N \to \nu P^0 N$ processes producing pseudoscalar mesons as well as of experimentally unobservable meson transitions $M(R) \to P^0 \nu \bar{\nu}$ and weak decays $P^0 \to \nu\bar{\nu}\gamma$, theoretical calculations are made pertaining to production of π^0, η, η' mesons in weak neutral currents as a result of neutrino scattering by a reggeon (weak meson) at the nucleon periphery or by the Coulomb field of a proton. Expressions are derived for the amplitudes of such production in a hadron vector current and in a hadron axial current, the amplitudes of these currents being determined on the basis of applicable models and hypotheses. Expressions are derived to describe the differential cross-sections for the respective production processes, whereupon numerical estimates of total cross-sections are made. Effects of higher-spin mesons and of scattering by a nucleus, by an isoscalar meson (ω,f) or a pomeron are also estimated. The authors thank S. S. Gershteyn for steady interest and valuable comments, also B. A. Dolgoshein, V. S. Kaftanov, V. D. Khovanskiy, and M. G. Ryskin for discussion. Figures 2; references 24: 8 Russian, 16 Western.

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ENERGY DEPENDENCE OF PROBABILITY OF FISSION OF TRANSURANIUM NUCLEI BY FAST NEUTRONS

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 2, Feb 87
(manuscript received 22 Jan 86) pp 319-328

[Article by G. N. Smirenkin and B. I. Fursov, Institute of Power Engineering Physics, Obninsk]

[Abstract] The dependence of the fission probability $P(E_n,Z,A)$ on the energy E_n of fast bombarding neutrons is evaluated over the neutron energy range up to 20 MeV for the entire series U - Cf of transuranium nuclei with corresponding Z and A numbers. An experiment involving a single cycle of measurement of the cross-section for fission as a function of the neutron energy has revealed that the sensitivity of the fission probability to change in the neutron energy is maximum for ^{236}U, ^{238}U, ^{241}Am, ^{243}Am target nuclei and that inherent differences between even and odd nuclei become evident within the first plateau below 5 MeV of this dependence, N-even ones requiring a higher energy for fission than do N-odd ones. As the mass number A-1 or the neutron number N increases, the quantity $\beta = p^{-1}dp/dE_n = d(\log P)/dE_n$ increases for U isotopes and decreases for Pu and probably also Am isotopes. The fissionability characteristics of these nuclei above the threshold of the (n,n',f) reaction and cross-sections for fission of nuclei with Z 95 are calculated and interpreted on these data and theoretical considerations. Figures 6; tables 1; references 30: 15 Russian, 15 Western (2 in Russian translation).

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MICROJUNCTION SPECTROSCOPY OF POPULATIONS IN TWO-LEVEL SYSTEMS

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12) Dec 86 (manuscript received 20 Jun 86) pp 2243-2251

[Article by V. I. Kozub and I. O. Kulik, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences]

[Abstract] A problem of microjunction spectroscopy is analyzed, namely scattering of electrons by low-energy excitation centers constituting two-level systems and its nonlinear contribution to the current-voltage characteristic of a metal microjunction. Elastic scattering is considered as well as inelastic scattering, predominantly fast relaxing excitation centers being involved in the latter. Slowly relaxing excitation centers scatter electrons elastically and also play some role in spectroscopy of populations in two-level systems, while behaving like plain impurities. Slow relaxation moreover contributes to an appreciable frequency dispersion of nonlinear conductance in the low-frequency range. The nonlinear component of the microjunction current I is determined from the equation of kinetics for populations in excitation centers which interact with the electronic subsystem, considering first the static case of a constant applied voltage V and then the dynamics of the microjunction conductance spectrum $\frac{d^2I(V)}{dV^2} = \frac{1}{R}\frac{dR(V)}{dV}$ (R - resistance of microjunction). The frequency dispersion of the microjunction conductance R^{-1} is then calculated for a voltage varying as an arbitrary periodic function of time $V = V(t + T_0)$, of special interest for experiments being the second harmonic component of the response to a voltage with a large constant component and a small sinusoidally alternating one. The results confirm that purely elastic interaction involving two-level systems reveals the nonlinear voltage dependence of the microjunction resistance necessary for successful spectroscopy of such systems. Figures 3; references 20: 12 Russian, 8 Western (1 in Russian translation).

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EFFECT OF PHONON NONEQUILIBRIUM ON OPTICAL DICKE SUPERRADIANCE

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 21 Feb 86, after revision 27 Jun 86) pp 1990-2000

[Article by S. N. Andrianov, P. V. Zinovyev, Yu. V. Malyukin, Yu. V. Naboykin (deceased), V. V. Samartsev, N. B. Silayeva and Yu. Ye. Sheybut, Kazan Institute of Engineering Physics, USSR Academy of Sciences; Institute of Low-Temperature Engineering Physics, UkSSR Academy of Sciences]

[Abstract] The phenomenon of optical Dicke superradiance is analyzed in the case of an impure molecular crystal with local heating of the lattice to a temperature other than that of the impurity so that a nonequilibrium of phonons results as the interval between pulses of pumping energy decreases. The theory is based on the Hamiltonian of the host-impurity system and corresponding equations of kinetics for pseudolocalized phonons in the second order of perturbation theory. This system of equations is solved analytically for interaction of pseudolocalized phonons and lattice phonons, assuming a weak electron-phonon interaction and considering the effect of cubic anharmonicity. The solution indicates that cubic anharmonicity additionally slows down relaxation of electron excitation into the thermostat while speeding up establishment of a quasi-equilibrium between pseudolocalized phonons and resonance lattice phonons. Numerical estimates are made for a diphenyl crystal containing 0.25 mol.% pyrene, on the basis of an experimental study made at temperatures of 1.5-4.2 K. Bar specimens 0.4 cm long and 0.1x0.1 cm^2 in cross-section were excited, superradiance resulting at the 0-0 ($^1B_{2u} \rightarrow {}^1A_g$) transition in pyrene at the λ = 373.9 nm wavelength. Three lasers with different degrees of emission pulse coherence were used as excitation source: 1) N_2-laser (wavelength λ = 337 nm, width of spectrum $\Delta\nu \approx 10$ cm^{-1}, pulse duration Δt_p = 8 ns), 2) YAD:Nd^{3+} laser (wavelength λ = 354.7 nm, width of spectrum $\Delta\nu \approx 0.1$ cm^{-1}, pulse duration Δt_p = 10 ns), 3) neodymium-glass laser (wavelength λ = 353.2 nm, width of spectrum $\Delta\nu \approx 25$ cm^{-1}, pulse duration Δt_p = 10 ns). Superradiance was recorded in each case, its intensity not depending on the excitation with respect to degrees of monochromaticity and coherence but its spectral characteristics depending on the width of the excitation spectrum. Both theoretical analysis and experimental evidence prove that the spectrum of superradiance in impure crystals changes with successive emission pulses as a result of preceding local temperature rises, depending on the repetition rate of excitation pulses. Figures 5; references 15: 6 Russian, 9 Western (3 in Russian translation).

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STIMULATED RAMAN SCATTERING OF PICOSECOND LIGHT PULSES IN LONG DISPERSIVE MEDIUM

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 20 May 86, after revision 2 Jul 86) pp 2031-2038

[Article by Ye. M. Dianov, L. M. Ivanov, A. Ya. Karasik, P. V. Mamyshev and A. M. Prokhorov, Institute of General Physics, USSR Academy of Sc ences]

[Abstract] Stimulated Raman scattering of picosecond laser radiation pulses in glass and quartz is considered, of concern being the effect which dispersion of group velocities ir a medium with group delay and a wide spectrum of irregular vibrational resonances has on the performance of fiber optics. An experimental study was made using a special picosecond spectrometer with a multichannel analyzer and with a nonlinear crystal ($Ba_2NaNb_5O_{15}$) as parametric light generator tunable over the 0.74-1.9 μm wavelength range by regulation of its temperature. This crystal, synchronously pumped by second-harmonic radiation (λ = 0.532 μm wavelength) from a YAG:Nd^{3+} laser with Q-switching and active mode locking, emitted pulse trains of 200 ns duration at a repetition rate of 400 Hz with smooth ultrashort pulses of 30 ps duration in 4 ns intervals within each train. These radiation pulses were sent through a 250 m long fiber with a core of fused quartz 10 μm in diameter inside a glass shell, the difference between the respective two refractive indexes being approximately $4 \cdot 10^{-3}$. The radiation pulses leaving the fiber were focused on the slit of a polychromator for analysis with the aid of a vidicon, an autocorrelator, and a computer. The fiber was also excited with smooth long radiation pulses of 150 ns duration directly from the YAG:Nd^{3+} laser (λ = 1.064 μm wavelength) with Q-switching only. In this scheme with multistage stimulated Raman scattering each Stokes component pumped the next one so that the entire infrared transparence window of quartz was covered as a result. On the basis of recorded spectra and with parameters of the experiment have been calculated the interaction length for pumping waves and stimulated Raman scattering waves as well as its dependence of the Stokes wavelength and then the dependence of the increment of scattering gain as well as of the frequency shifts of Stokes components on the pumping radiation wavelength. Into account were taken dispersion of group velocities and duration of pumping pulses, considering also that stimulated Raman scattering. like spontaneous Raman scattering, is a noise phenomenon. Figures 6; references 14: 8 Russian, 6 Western (1 in Russian translation).

2415/5915
CSO: 1862/98

STIMULATED MANDELSTAM-BRILLOUIN SCATTERING DURING FORWARD SCATTERING OF LIGHT

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 25 Feb 86) pp 2001-2007

[Article by V. D. Kagan, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences]

[Abstract] Stimulated Mandelstam-Brillouin scattering of light by sound in an anisotropic forward scattering medium is analyzed theoretically, forward scattering being possible in a birefringent crystal but not in an isotropic medium subject to laws of frequency and wave vector retention. The intensity transfer from incident light to scattered light by sound is described by a system of three wave equations. Since the space intergrals and the time integrals of varying amplitudes here are much larger than the corresponding wavelengths and wave periods respectively, this system of equations can be replaced by a system of three short field equations with the two light waves (incident and scattered) represented by their respective electric field components E_0 and E_1. This system is made completely integrable, as for stimulated Raman scattering, by disregarding all time derivatives of amplitudes and beyond the attenuation distance also the space derivative of the sound wave amplitude. The system is then solved for the appropriate initial and boundary conditions, compatibility with the natural boundary conditions requiring inclusion of the initial sound wave amplitude and thus the thermal noise it stimulates. In the linear theory of transient stimulated Mandelstam-Brillouin scattering, with the amplitude of the incident wave assumed to be constant, the first two equations with E_1 and E_2 appearing separately reduce to a single expression with a space integral under the given boundary conditions. Insertion of this expression into the third equation containing the product E_0E_1 reduces the system to a single sine-Gordon nonlinear partial differential equation with the corresponding initial condition for that integral. A comparison with steady stimulated Mandelstam-Brillouin scattering indicates that the region of efficient interaction with attendant intensity transfer shifts in time from the interior of a crystal toward its front face, parametric interaction in the interior becoming overwhelmed by noise as steady state is reached. During the transient period the solution yields a reverse transfer of intensity from the scattered wave to the incident wave at infinity, this reverse transfer being eventually abated by attenuation of the sound. References 5: 3 Russian, 2 Western.

2415/5915
CSO: 1862/98

UDC 535.37+543.42

MICROSPECTROFLUORIMETRY OF SOLIDS

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR: SERIYA FIZIKO-MATEMATICHESKAYA in Russian No 6(133), Nov-Dec 86 (manuscript received 10 Mar 86) pp 30-33

[Article by Ye. A. Kurmanbayev and S. Sh. Madina, Institute of Geological Sciences imeni K. I. Satpayev, KaSSR Academy of Sciences, Alma-Ata]

[Abstract] Microspectrofluorimetry, now widely used for examination of organic substances, can also be used for examination of inorganic ones and especially of minerals containing luminescent inclusions. A microspectrofluorimeter for this purpose has been built on the basis of a "Reichert" MeF-2 metallographic microscope and a DMR-4 monochromator, including a DRSh-250 ultraviolet mercury-arc lamp and a UFS-1 light filter. It operates either in the reflection mode, an objective lens with large aperture ensuring a high sensitivity by virtue of the fourth-power law, or in the transmission mode allowing excitation of a specimen throughout its volume. Localization within an area 10 μm wide is achieved by vignetting with a diaphragm while glow is observed through the eyepiece, and recording an entire spectrum requires a time less than 120 s. The instrument was used for comparing the photoluminescence spectra of natural sphalerite and activated ZnS crystals, with Cu^{+}, Mn^{2+}, Fe^{2+}, Cd^{2+} impurity ions. Its sensitivity was established by calibration against laser spectral microanalysis of a standard "carbon filament - pyrite 80" specimens. The method is not universal, however, owing to the limited number of luminescent minerals and luminophorous impurities. Figures 2; tables 1; references 2: Russian.

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CSO: 1862/125

SELF-ACTION AND ULTIMATE COMPRESSION OF OPTICAL FEMTOSECOND WAVE PACKETS IN NONLINEAR DISPERSING MEDIUM

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 2, 25 Jan 87 (manuscript received 17 Dec 86) pp 73-76

[Article by Ye. A. Golvochenko, Ye. M. Dianov, A. N. Pilpetskiy, A. M. Prokhorov and V. N. Serkin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Self-action of femtosecond wave packets with narrow frequency and angle spectra in a dispersing medium such as glass is analyzed in the approximation of nonlinear quasi-optics, wave packets with an envelope subtending only a few field oscillation cycles in a medium with an electric induction vector not describable in this approximation presenting a fundamentally new problem. The problem is solved by the method of slowly varying amplitudes. The corresponding equation, which follows from Maxwell equations and includes linear

dispersion effects of third-order smallness with respect to the parameter T/τ_0 (T - mean wave period, τ_0 - initial duration of packet envelope) as well as nonlinearity dispersion, describes the dynamics of such wave packets. The limiting values of wave packet parameters at which the approximation of the nonlinear Schrödinger equation ceases to be valid are estimated, whereupon the ultimate wave compression is established from the condition for decay of a wave packet into "color" solitons. The analytical results indicate the possibility of efficient stimulated Raman scattering, with conversion of a pulse "on itself" so that its "blue" spectral components pump its "red" ones. The results of numerical experiments indicate that stimulated Raman self-dispersion can cause decay of coupled soliton states without inhibiting ultimate self-compression of pulses. Figures 3; references 3: 2 Russian, 1 Western.

2415/5915
CSO: 1862/138

DYNAMICS OF EXCITED ELECTRONIC STATES IN POLYATOMIC MOLECULES: PICOSECOND SPECTROSCOPY WITH COHERENT ANTISTOKES LIGHT SCATTERING

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 2, 25 Jan 87 (manuscript received 4 Dec 86) pp 69-72

[Article by V. F. Kamalov, V. V. Kvach, N. I. Koroteyev, B. N. Toleutayev, A. Yu. Chikishev, and A. P. Shkurinov, Moscow State University imeni N. V. Lomonosov]

[Abstract] The vibrational structure and relaxation processes of picosecond duration in excited electronic states in polyatomic molecules, molecules of nickel octaethyl-porphyrin, were studied by the method of coherent anti-Stokes light scattering after the electronic subsystem of these molecules had been excited by optical picosecond pulses. The spectrometer with a 50 ps time resolution used in the experiment had a YAG:Nd^{3+} laser with acoustooptic mode locking and Q-switching for excitation of molecules with second-harmonic picosecond power pulses and a synchronously pumped tunable dye laser emitting trains of 80 ps pulses at repetition rates up to 5 kHz for probing. An electrooptic modulator extracted single second-harmonic pulses from pulse trains emitted by the YAG:Nd^{3+} laser. Such a pulse was split, only 90% of its energy being used for excitation of molecules (frequency ω_e) and 10% of its energy (frequency ω_1) being passed together with a pulse from the dye laser (frequency ω_2) through a delay line to provide two probing waves. The "pedestal" in the spectrum of coherent anti-Stokes light scattering (frequency $2\omega_1 - \omega_2$) was removed by polarizational suppression of nonresonant hum. A solution of nickel octaethylprophyrin in tetrahydrofuran, its concentration not exceeding 10^{-4} M, was used for the experiment and measurements were made at room temperature. The results of such a spectroscopy have yielded information about the dynamics of excited electronic states, most importantly about changes in the

Raman scattering spectrum of the excited electronic state which has the longest lifetime. This is the T_d triplet state, characterized by preferential excitation in a Ni atom with the π-electron system remaining almost unperturbed. Its lifetime was found to be 290±50 ps, close to that based on differential absorption spectroscopy of nickel porphyrins in toluene solution. The authors thank S. A. Akhmanov, P. A. Apanasevich and V. A. Orlovich for steady interest and helpful discussions, also A. M. Shulga for synthesizing and supplying specimens. Figures 3; references 9: 4 Russian, 5 Western.

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UDC 535.417+535.317.1

COMPARISON OF SENSITIVITY AND PRECISION OF HOLOGRAPHIC AND SPECKLE-INTERFEROMETRY METHODS WITH FOURIER-PLANE RECORDING

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86 (manuscript received 22 May 85) pp 1118-1122

[Article by I. S. Klimenko, V. P. Ryabukho and B. V. Feduleyev]

[Abstract] The two-exposure speckle-interferometry method has been supposed to be less sensitive than holographic interferometry methods; however speckle-interferometry sensitivity has been found to approach that of holographic interferometry for the measurement of rotational shifts. With Fourier-plane recording, both methods have the same sensitivity to rigid shifts and comparable sensitivity to flexible deformation. If there is no lense aberration both methods have the same sensitivity threshold for objects of the same size as the lense apertures. A study was made of the comparative sensitivity to rigid shifting of the two methods with Fourier-plane recording for objects smaller than the lense apertures when the speckle parameters are determined by the object shapes and sizes and the illumination dispersion rather than by lense aperture size. For both methods, the measurement data is supplied by the interference pattern whose parameters are band contrast and period and the size and spatial distribution of the field intensity of the interference pattern. The band period in relation to the shift magnitude determines sensitivity whose threshold affects measurement precision. The two methods were tested by a single apparatus for producing holograms and speckle-interferograms on photographic plate using a weak reference beam half as intense as the object beam. The measurement sensitivity threshold was found to be determined by the size of the field in which the interference pattern forms and this was twice as great for the speckle-interferogram which thus had twice as many bands. Since the interference patterns in both cases had the same period, the two methods have the same sensitivity to object shifting. The speckle-interferometry method is superior to holographic interferometry for the measurement of various types of rigid movement and for vibration amplitude measurements. Figures 2; references 10: 2 Russian, 8 Western (2 in Russian translation).

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CSO: 1862/73

UDC 535.2

ANOMALOUS EVOLUTION OF OPTICAL SOLITONS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86
(manuscript received 29 Dec 84) pp 1058-1063

[Article by S. O. Yelyutin and A. I. Maymistov]

[Abstract] Solitons are utilized in the theory of selfinduced transmittance based on Maxwell-Bloch equations. The soliton solution of these equations applies to ultrashort light pulses propagating in a resonance medium without absorption. The inverse scattering problem method is utilized for solution of the Maxwell-Bloch equations for determining the number of solitons and their amplitude, length and phase starting from the initial ultrashort pulse envelope. It was found that the number of solitons varied from one to three depending upon the time interval separating two square ultrashort pulses entering the resonance medium provided that the pulse areas were within certain limits. However, there is an anomaly since according to the area theorem each pulse can only form one soliton so that there should never be three solitons. A solution is given for this anomaly utilizing the inverse scattering theory and numerical modelling of the evolution of ultrashort pulses supports the procedure presented. It was also observed that in addition to the solitons and a linear dispersion wave produced by the ultrashort pulses, a nonlinear signal or pseudo-echo formed preceding the solitons which has a speed less than the speed of light in the medium. The solitons completely replace the original ultrashort pulses after the attenuation of the linear dispersion wave but the pseudoecho has a lifespan significantly longer than the latter. Figures 3; references 15: 6 Russian, 9 Western (1 in Russian translation).

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UDC 535.2

FOUR-LEVEL STIMULATED PHOTON ECHO

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 5, Nov 86
(manuscript received 14 Apr 86) pp 1053-1057

[Article by I. V. Yevseyev and V. A. Reshetov]

[Abstract] The photon echo phenomenon can be utilized in optical information processing system because of the correlation effect which was theoretically predicted and then observed in ruby and gas. The correlation effect consists of the fact that for certain conditions the echo signal repeats the time-reversed shape of the first exciting momentum. One variant (observed in ruby and gas) is the stimulated photon echo which can repeat the shape of one of three exciting momenta. Another variant, modified stimulated photon echo, differs from the usual echo effect and the stimulated effect (both with two-level systems) and can repeat the shape of one of the exciting momenta either

in the original sequence or time-reversed although the signal is extended or compressed. However, information storage time for this variant is short because there is a resonance level with a short lifetime linked to the main optically permitted transitions. A new variant of the photon echo phenomenon in gas, four-level stimulated photon echo, is proposed which is a system of four energy levels (a, d, b, f in order of increasing E) excited by three momenta. The four-level echo variant has all the features of the modified stimulated photon echo system but it increases the information storage time because the information is stored by atoms at the metastable d level. The transitions b to a, b to d and f to d are considered optically permissible while the transition from the metastable level d to a is optically forbidden. A theoretical description is given of the proposed procedure. References 8: 7 Russian, 1 Western.

12497/5915
CSO: 1862/73

UDC 535.8:666.189.211

PRESSURE AND TENSION DEPENDENCE OF PHASE SHIFT OF POLARIZATION MODES IN BIREFRINGENT SINGLE-MODE FIBER-OPTIC WAVEGUIDE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87 (manuscript received 2 Jun 86) pp 472-474

[Article by F. A. Shatalov]

[Abstract] The dependence of the phase shift of polarization modes in a birefringent single-mode fiber-optic waveguide is analyzed theoretically, for a q-layer ($q \geq 2$) cylindrical structure consisting of q-1 coaxial shells around a core with linear birefringence. Axial tension, radial pressure, and hydrostatic pressure are considered each separately as modes of external action on the waveguide, sensitivity of the phase shift to change in any of them being determined by the resulting change in both refractive indexes and in the fiber length. Change in the core geometry and in its contribution to the birefringence is assumed to be negligible. Exact analytical expressions are obtained on this basis for the corresponding sensitivity coefficients, representing sensitivity to change in tension or pressure respectively. These expressions are readily approximated for simple evaluation. The author thanks V. V. Velikov, V. A. Lebedev and V. N. Tsalkov for discussion. References 6: 5 Russian, 1 Western.

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CSO: 1862/140

UDC 621.373:535.06

HIGH-SENSITIVITY RECORDING OF WEAK REFLECTED OR SCATTERED RADIATION BY METHOD OF COHERENT INTRACAVITY RECEPTION WITH YAG:Nd^{3+} LASER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87 (manuscript received 27 Jun 86) pp 430-436

[Article by Ye. A. Viktorov, N. M. Galaktionova, A. A. Mak, O. A. Orlov, Ye. V. Tkachenko and V. I. Ustyugov]

[Abstract] High-sensitivity measurement of small reflection and scattering coefficients by the method of intracavity reception of the weak signal using a single-mode continuous-wave YAG:Nd^{3+} laser (λ = 1.06 μm wavelength) with an additional mirror is evaluated, such measurements having already been made with a He-Ne laser (λ = 0.63 μm wavelength). The resonator cavity containing the laser crystal for such a interferometer is formed by a plane mirror and a concave spherical one. The latter mirror passes single-frequency radiation to a modulator, through a lens and a filter set. The piezoceramic modulator generates an alternating electric signal and reflects the radiation onto the test object, through the additional forward and backward moving mirror. Two traps behind the object absorb radiation transmitted by it. Radiation reflected or scattered by the object and containing sought information returns to the resonator cavity and, after passing through the plane mirror, impinges on a photodetector whose electric output signal is recorded. An analysis of this measurement process, taking into account the Doppler shift which reflection by the moving mirror has produced and disregarding the negligible phase dependence of the laser emission frequency, yields an analytical relation for the instrument sensitivity and the noise immunity threshold of signal power. The role of frequency modulation is examined, this mode of operation ensuring that a sufficiently strong signal enters the noisy photodetector but also degrading the sensitivity of measurements. Theoretical calculations indicate that a YAG:Nd^{3+} laser, being more powerful and having better dynamic characteristics, ensures a sensitivity one order of magnitude better than does a He-Ne laser.

In an experiment, a continuous-wave single-mode YAG:Nd^{3+} laser with pumping by a krypton-arc lamp and with automatic frequency control using an appropriate selector for single-frequency emission was found to facilitate detecting and recording weak reflection with a sensitivity $\sqrt{(r_{eff})_{min}/\Delta f} = 1.5 \cdot 10^{-8}$ $Hz^{-1/2}$ (r_{eff} - effective reflection coefficient, Δf - frequency deviation) at the level of laser noise. The authors thank V. B. Polyakov and N. S. Ogoltsov for helpful discussions, S. V. Kruzhalov and G. F. Zaytsev for collaboration in producing a single-frequency laser. Figures 4; references 12: 7 Russian, 5 Western (2 in Russian translation).

2415/5915
CSO: 1862/140

UDC 535.612(206.3):537.29+538.6

OPTICAL ANISOTROPY OF GASEOUS MEDIA AND THREE-WAVE PARAMETRIC PROCESSES IN STRONG ELECTROMAGNETIC FIELD WITH CONSTANT MAGNETIC FIELD

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 19 Jun 86) pp 407-411

[Article by E. M. Verlan]

[Abstract] The optical anisotropy of Na vapor in a strong electromagnetic pumping field with a frequency ω_1 and a constant magnetic field is analyzed theoretically, also the three-wave parametric $\omega_1 + \omega_2 = \omega_3$ process during resonance at the 3s—4p ($\omega_1 + \omega_2 \approx \omega_{3s}^{4p}$) transition. Calculations are made for an elliptically polarized pumping wave off resonance with atomic transitions, a weak field of the ω_2- signal wave, and a magnetic field parallel to the Z-axis along which both waves propagate. Linear and nonlinear components of a probing ω_3-wave at resonance with the 3s—4p transition are considered. The medium is found to remain anisotropic and gyrotropic for the probing wave upon removal of the magnetic field, but to become isotropic upon removal of both magnetic and pumping fields. The three-wave parametric process involving two-photon transition 3sm→4pqJ and subsequent electric-dipole radiation emission is described by the same method, which yields a simple expression for the amplitude of the sum-frequency field. References 5: all Russian.

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UDC (535.34+535.375)548.0

EFFECT OF FERROELASTIC PHASE TRANSITIONS ON EDGE ABSORPTION AND RAMAN SCATTERING SPECTRA OF $Ba_2NaNb_5O_{15}$ SINGLE CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 21 Feb 86) pp 368-371

[Article by A. F. Gumenyuk, O. I. Oleynik and V. A. Omelyanenko]

[Abstract] Absorption at the edge of the fundamental band and Raman scattering in $Ba_2NaNb_5O_{15}$ single crystals are analyzed, this nonlinear optical material having a 4/mmm point symmetry at temperatures above 858 K, a 4mm symmetry characterizing a tetragonal structure at temperatures from 858 K of ferroelectric phase transition to 573 K of the first ferroelastic phase transition, an mm^2 point symmetry characterizing an orthorhombic structure at temperatures from 573 K to 110 K of the second ferroelastic phase transition, and again a 4mm symmetry below 110K. The absorption spectra were measured by the method of two specimens with different thicknesses at temperatures of 5-600 K, in light

polarized one perpendicularly and once parallel to the crystallographic c-axis, 600 cm^{-1} being the maximum recorded value of the absorption coefficient. The results indicate an inverse temperature dependence of the quantum energy at constant absorption levels. A comparison with results of theoretical analysis based on the Urbach rule, with the absorption coefficient in both polarization modes depending exponentially on the quantum energy as well as on the reciprocal of the temperature, reveals an anomaly of edge absorption attributable to the Frantz-Keldysh effect in the orthorhombic phase. Measurement of the Raman scattering spectra in zz-polarized light at temperatures of 80-200 K reveals two dominant groups of bands with peaks near 300cm^{-1} and at 661 cm^{-1} respectively. They also reveal an anomaly in the orthorhombic phase, namely a shifting of the lowest-frequency line to higher frequency at higher temperature, evidently caused by displacement of the NbO_3 octahedra without significant distortion of their symmetry. The authors thank I. S. Gorban for helpful comments, advice, and discussion. Figures 4; references 8: 2 Russian, 6 Western.

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STRENGTH DISTRIBUTION OF OSCILLATORS IN X-RAY ABSORPTION SPECTRUM OF N_2-MOLECULE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87 (manuscript received 16 Jul 86) pp 340-345

[Article by A. V. Zhadenov, V. N. Akimov and A. S. Vinogradov]

[Abstract] Experimental data on the strength distribution of oscillators within the fine structure of the K-band absorption spectrum of a nitrogen molecule have been obtained by measuring the absolute cross-sections for absorption within the range of sharp near-threshold resonance. Measurements within the 390-450 eV energy range were made on an RSM-500 spectrometer with an X-ray tube serving as radiation source, a plane aluminum-coated mirror oriented at a 2°53' angle serving as filter of ultrashort-wave radiation (wavelengths smaller than 17 Å), and a methylal-filled proportional counter serving as detector. Both TiL$_\gamma$-line radiation and bremsstrahlung were used in this photoabsorption experiment. The pressure dependence of the $(\mu p)_{eff}$ product (μ- absorption coefficient, p-gas pressure) and polychromatic background absorption are calculated, considering that the cross-section for polychromatic absorption over the entire continuous ultrasoft-X range is much smaller than the cross-section for monochromatic absorption at the π_g-resonance peak. The results yield an oscillator strength $f = 0.21$, comparable with that obtained in some but not all other experimental and theoretical studies. The data on three characteristics of the NK-spectrum, namely π_g and σ_u resonances and Rydberg transition peaks,

indicate that theoretical calculations by the Hartree-Fock method in the approximation of a "frozen in" atom shell with application of Stiltjes-Chebyshev moments yield an absorption spectrum fitting the experimentally determined one most closely. Figures 2; tables 2; references 21: 6 Russian, 15 Western.

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UDC 535.13

DISPERSION LAW FOR NONLINEAR SURFACE TRANSVERSE MAGNETIC MODES AT BOUNDARY BETWEEN MEDIA WITH OPTICAL EXCITON-TO-BIEXCITON CONVERSION PROCESSES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87 (manuscript received 22 May 86) pp 468-471

[Article by Ye. S. Kiseleva and P. I. Khadzhi]

[Abstract] Nonlinear surface waves at the boundary between two media are considered, one medium being a nonlinear semiconductor and the adjacent medium being a linear dielectric. An expression for the dielectric permittivity of the first medium as a function of the field amplitude (attenuation) is derived from the Bloch equations and the Hamiltonian describing optical exciton-biexciton transitions into the luminescence M-band, the nonlinearity of surface waves being a consequence of optical exciton-to-biexciton conversion. On the basis of that expression, which describes the dielectric permittivity of the first medium, the dispersion law is derived for such waves propagating in the TM mode. Numerical analysis of this dispersion law, applicable to a CdS crystal on an isotropic substrate, yields the conditions for existence of surface polaritons. In graphical form it is represented by a U-curve with an asymptotically rising branch and an almost horizontal and straight curve above. As the electric field intensity increases, the nearly straight upper curve drops down till it merges with the rising branch of the U-curve so that the latter reverses and the now single curve shrinks toward the frequency axis. Figures 1; references 8: all Russian.

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UDC 539.184.5:546.59

LASER PHOTOIONIZATION SPECTROSCOPY OF HIGHLY EXCITED STATES IN Au-ATOM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 2, Feb 87
(manuscript received 6 Aug 86) pp 273-278

[Article by G. I. Bekov, A. T. Tursunov, G. Khasanov and N. B. Eshkobilov]

[Abstract] An experimental study of Rydberg and autoionization states in an Au atom was made, its purpose being to determine the optimum excitation and ionization modes for quantitative analysis in practical applications such as gold mining and refining. The apparatus consisted of three dye-laser stages and a transverse-discharge N_2-laser pumping them with pulses at a repetition rate of 5 Hz, a KDP crystal for second-harmonic extraction, a high-voltage source and a spark discharger, and a high-temperature furnace inside a vacuum chamber for generating an Au-atom beam. From the first two dye lasers were extracted second-harmonic emission pulses of 5 μJ and 10 μJ energy respectively, sufficient for saturating transitions in Au atoms. Radiation at wavelengths within the 440-520 nm range from the third dye laser was attained by using appropriate standard solutions (4-MU in $HCl+H_2O$, KOH in coumarin-47) and correspondingly regulating the emission pulse energy over the 10-30 μJ range. Operation of this laser with a sliding beam incidence ensured a narrow-band spectrum with a 0.4 cm^{-1} linewidth. The beams of all three lasers were deflected by mirrors into the vacuum chamber and focused within the interelectrode gap through which the Au-atom beam was passing. Spectra were recorded with a spectrograph, while measurements were made with a strobing pulse voltmeter through a secondary-electron multiplier and through a Fabry-Perot etalon followed by a lens and a photodiode. From the readings were determined wavelengths of $5d^{10}7s^2S_{1/2} \rightarrow 5d^{10}np^2P^0_{1/2,3/2}$ transitions in AuI as well as energy, effective quantum numbers, and quantum defects of np^2P^0-states in an Au atom, a quantum defect depending on both the principal quantum number n and the T_n-level energy read from the ionization edge I_i. The results reveal fine splits of several np-states in AuI with $n \leq 20$ and several autoionization states in AuI near the ionization edge. Figures 4; tables 1; references 6: 1 Russian, 5 Western (1 in Russian translation).

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UDC 533.951

EXPERIMENTAL STUDY OF 'PLASMA-ELECTRON BEAM' WITHOUT MAGNETIC FIELD

Moscow FIZIKA PLAZMY in Russian Vol 13, No 2, Feb 87
(manuscript received 16 Sep 85, after correction 26 Feb 86) pp 224-228

[Article by M. A. Zavyalov, S. G. Mikhin and V. A. Tarasenkov, All-Union Institute of Electrical Engineering imeni V. I. Lenin]

[Abstract] An experimental study of a "plasma-electron beam" system was made concerning the x-radiation emitted from the gaseous space during passage of the electron beam through it in the absence of a magnetic field. The gas pressure was varied over the $4 \cdot 10^{-5}$-$5 \cdot 10^{-3}$ mm Hg. Measurements were made in two facilities, each with a cathode-ray tube operating in the steady-state mode. The electron energy was varied over the 5-20 keV range in the first facility and held constant at 30 keV with the beam power varied up to 200 kW in the second one. Measurements have yielded the pressure dependence of the bremsstrahlung intensity, the pressure dependence and the current dependence of the x-ray spectrum, the pressure dependence of the integral x-radiation intensity and of the saturation ion current to the probe, also the pressure dependence of the plasma density and of the critical beam current with a pressure threshold both. Figures 7; references 12: 11 Russian, 1 Western.

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DRIFT-ALFVEN VORTICES

Moscow FIZIKA PLAZMY in Russian Vol 13, No 2, Feb 87
(manuscript received 31 Oct 85, after correction 20 Feb 86) pp 188-196

[Article by V. P. Lakhin, A. B. Mikhaylovskiy and O. G. Onishchenko, Institute of Space Research, USSR Academy of Sciences]

[Abstract] Existence of drift-Alfven vortices in a nonuniformly magnetized plasma is examined theoretically in the approximation $g \simeq T_e/m_i R \to 0$ (T_e - electron temperature, m_i - ion mass, R - effective radius characterizing curvature of magnetic field). The hydrodynamics equations are derived for nonlinear

drift-Alfven waves in the two cases of $\beta > m_e/m_i$ and $\beta < m_e/m_i$ (β - ratio of plasma pressure to magnetic field pressure, m_e - electron mass), these equations being of the fourth degree in the electric potential and in the skin-layer depth respectively. They are reduced to a single canonical form, convenient for analysis of dipole drift-Alfven vortices and derivation of their dispersion equation. References 15: 5 Russian, 10 Western.

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UDC 533.951

PRODUCTION OF HOT RESONANT IONS IN PLASMA WITH DEVELOPED ION-ACOUSTIC TURBULENCE

Moscow FIZIKA PLAZMY in Russian Vol 13, No 2, Feb 87
(manuscript received 26 Mar 86) pp 181-187

[Article by V. P. Silin and S. A. Uryupin, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Production of hot ions in an ion-acoustically turbulent plasma is analyzed in the quasi-linear approximation, on the premise that heating of thermal ions upon attenuation of sound by ion-ion collisions is not less significant than their heating upon induced scattering of ion-acoustic waves by ions and that the frequency of those collisions is sufficiently high for assuming a Maxwell distribution of ions. Calculations based on the theory of ion-acoustic turbulence, with the Knudsen number $N_{Kn} \ll (1+\delta)^2$ (δ - dimensionless parameter characterizing attenuation of ion-acoustic waves by resonant ions), yield a system of two ordinary differential equations for the rates of change of electron temperature and majority-ion temperature respectively as functions of the mean-in-time electron temperature each. Solution of these equations for the two extreme cases of $\delta \ll 1$ and $\delta \gg 1$ yields in each case the heating of resonant ions as a function of time. Only short time periods need to be considered when $\delta \ll 1$, in which case majority ions are heated fast while the number of resonant ions increases exponentially. In the other case both majority-ion and resonant-ion temperatures as well as the electron temperature increases quadratically in time. These extreme cases indicate the trend. General laws of energy and momentum redistribution during anomalous transfer processes in a system of particles and waves such as an ion-acoustically turbulent plasma have been applied in these calculations. The results are extended to hot impurity atoms, revealing a strong dependence of their effective temperature on their charge number and atomic number. References 16: 8 Russian, 8 Western.

2415/5915
CSO: 1862/144

UDC 533.9.082

THEORY OF IONIC HEAT TRANSFER IN TOKAMAKS

Moscow FIZIKA PLAZMY in Russian Vol 13, No 2, Feb 87
(manuscript received 11 Feb 86, after correction 14 Apr 86) pp 131-138

[Article by Yu. V. Gott and E. I. Yurvhenko, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] The problem of energy transfer through an ionic channel in a tokamak is examined without the two simplifying assumptions of the standard neoclassical theory. Accordingly, the ion distribution is allowed to arbitrarily deviate from a Maxwell distribution and the variation of both plasma density and temperature gradients over the width of a "banana" trajectory is allowed to be more than negligible so that neither the Larmor radius of an ion nor the width of a "banana" trajectory needs to be smaller than the characteristic plasma dimension. The plasma potential, needed for calculating the energy flux and the mass flux per unit area of confining surface, is determined from the condition of ambipolarity implying equal electron and ion fluxes. The energy flux is then equal to the heat transmitted owing to thermal conductivity of the plasma and owing to diffusion of particles. For qualitative and then quantitative analysis, the energy flux riding on confined particles is dealt with separately first by solution of their equation of kinetics in the τ-approximation. Then the energy flux associated with drifting particles, their distribution being periodic with respect to the poloidal angular coordinate, is analogously calculated from their kinetic equation. The analytical results are used for an evaluation of the total energy flux through an ionic channel, in the ideal case of a normal electron flux and in the more real case of an anomalous electron flux. The thus obtained much weaker than according to the standard neoclassical theory dependence of the energy flux on the frequency of collisions involving ions with finite Larmor radii and its almost linear dependence on the magnitude of the anomalous electron flux are compared with experimental data obtained in the T-11 tokamak facility and are supplemented with some numerical estimates. Figures 3; references 10: 5 Russian, 1 Hungarian, 4 Western.

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CSO: 1862/144

INTERACTION OF ACOUSTIC AND ELECTROMAGNETIC WAVES INVOLVED IN ANOMALOUS SKIN EFFECT

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 3 Apr 86) pp 2140-2149

[Article by A. P. Kopasov, Scientific Research Institute of Engineering Physics, Gorkiy State University imeni N. I. Lobachevskiy]

[Abstract] Action of a transverse electromagnetic wave on an electric conductor carrying a longitudinal acoustic wave with the displacement vector normal to the conductor surface is analyzed, the resulting anomalous skin effect being characterized by emission of electromagnetic radiation at the combination frequencies $\omega_e \pm \omega_a$ as a consequence of inevitable attendant nonlinearity. A conductor occupying the positive half-space is considered with an acoustic wave of a frequency ω_a equal to twice the frequency ω_e of the electromagnetic wave. The amplitudes of emitted waves at both combination frequencies are determined from the equation of kinetics for the electron distribution function, assuming specular reflection of electrons by the conductor surface and an isotropic law of electron dispersion. On the right-hand side of this equation is the collision integral and its left-hand side contains the derivative of the Hamiltonian with respect to the quasi-momentum for an electron in a deformed crystal. Calculations reveal that an acoustic wave adds to the electromagnetic surface impedance of the conductor, the magnitude of this increment depending linearly on the amplitude of the acoustic wave. In the case of sound with a wavelength of the same order of magnitude as the skin depth this increment will become comparable with the principal surface impedance when the characteristic oscillation frequency of electrons entrapped by the potential sound field is higher than their momentum relaxation frequency and the frequency of the electromagnetic wave. Such a condition is attainable in pure metals and semimetals, with a long mean free path for electrons, at low temperatures with sound of an intensity even lower than 1 W/cm^2.
References 10: 8 Russian, 2 Western.

2415/5915
CSO: 1862/98

INTERFERENCE EFFECTS DURING DYNAMIC DIFFRACTION OF NEUTRONS UNDER ULTRASONIC EXCITATION

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 21 Mar 86) pp 2132-2139

[Article by Ye. M. Iolin, E. V. Zolotoyabko, E. A. Raytman, B. V. Kuvaldin and V. N. Gavrilov, Institute of Physics, LaSSR Academy of Sciences]

[Abstract] Interaction of thermal neutrons and ultrasonic waves during Bragg diffraction of the former in a crystal, with resulting ultrasonic beats in the pendulum mode, is analyzed both theoretically and on the basis of an experimental study. The intensity of neutron scattering and its dependence on the sound wave amplitude is calculated, of special concern being ultrasonic excitation at and slightly above the threshold frequency related to the extinction length. Shifting of the neutron dispersion surface upon absorption or emission of an ultrasonic phonon is accounted for. Measurements with a neutron diffractometer by the Laue method were made in the IRT-M engineering research reactor at the Institute of Physics, using a Si single crystal and a transverse ultrasonic wave with a frequency of 19.250 MHz not far above the 14.7 MHz threshold propagating parallel to the reflecting ($2\bar{2}0$) crystal planes. An analysis of the diffraction patterns, taking into account interband interference particularly appreciable near the threshold frequency, reveals oscillations of the scattering intensity as a function of the sound wave amplitude caused by additional gaps forming on the neutron dispersion surface and oscillations of its derivative with respect to the sound wave amplitude during rotation of the crystal about the reciprocal-lattice vector. An analysis of these relations by the method of least squares indicates that near the threshold frequency the sharpness of both oscillations depends largely on the phase, shift of the neutron dispersion surface multiplied by thickness of the crystal plate, a control variable in the experiment. The authors thank I. R. Entin for helpful discussions, also Ye. N. Kozlov, A. K. Krigers and V. O. Nikolayev for assistance in automation of the experiment and processing the experimental data. Figures 5; references 9: 6 Russian, 3 Western.

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UDC 517.958:532.526

EQUATION OF GRAVITATIONAL-GYROSCOPIC WAVES: ANGULAR POTENTIAL AND ITS APPLICATIONS

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27, No 1, Jan 87 (manuscript received 12 May 85) pp 102-113

[Article by S. A. Gabov and Yu. D. Pletner, Moscow]

[Abstract] A theory of dynamic potentials, logarithmic and angular, has been developed for Sololev equations for solving certain external boundary-value problems. Here this theory is applied to the equation of gravitational-gyroscopic waves, specifically plane ones. Two theorems are proved pertaining

to the angular potential, whereupon the problem of a thin wing moving in an incompressible ideal Sedov fluid is formulated. The problem, gravitational-gyroscopic analog of finding a function which becomes harmonic outside a straight segment with generally different values on each side of that segment, is solved by the method of this theory rather than by the Sedov method with the Cauchy integral. An explicit solution is constructed on the basis of two applicable existence and uniqueness theorems with the aid of two lemmas. The behavior of this solution after a long time is analyzed on the basis of another theorem with the aid of another lemma and the existence of steady-state oscillations is established on the basis of additional three theorems. The authors thank A. G. Sveshnikov for his assistance. References 12: all Russian.

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NUMERICAL ANALYSIS OF MOTION OF SOLID BODIES IN ATMOSPHERE

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27, No 2, Feb 87 (manuscript received 19 Jul 85, after revision 16 Jan 86) pp 272-285

[Article by G. M. Lokhov and S. I. Podzorov, Moscow]

[Abstract] Numerical analysis of motion and flight dynamics of a solid body in the atmosphere is considered, asymptotic methods being particularly computer-efficient where equations with high-frequency terms need to be integrated. In this case the characteristic time for relative motion is assumed to be much shorter than the characteristic time for motion of the center of mass. Assuming further that the body is an ideal solid of revolution with its center of mass on its longitudinal axis of symmetry, that its principal axes of inertia are parallel to the corresponding axes of aerodynamic symmetry, and that its relative motion as well as the motion of its center of mass are motions in a plane, an optimum mathematical model is constructed in the form of systems of nonlinear ordinary differential equations is constructed which requires minimum computer time for numerical solution and simulation of flight dynamics on this basis. The pattern of relative motion can vary arbitrarily and perturbations can occur throughout the space and time segment under consideration. Directional cosines and Rodrigues-Hamilton parameters are used as kinematic parameters in the model, Euler-krylov angles being algorithmically less efficient in the case of supersonic flight. The systems of nonlinear ordinary differential equations are rigid, namely their Jacobians have a wide range of eigenvalues with negative real part so that fast decaying and slowly decaying terms appear in their solutions. The numerical methods of solving them, specifically difference methods, must be conservative, monotonic, and fast converging. These three criteria are satisfied by the implicit Runge-Kutta scheme, the Rosenbrok method, the Gear method, and even better by a combination of second-order and third-order explicit Runge-Kutta schemes or modular methods as well as by the explicit A-stable scheme. Both a CRAY-1

"conveyor" computer with sequentially operating processors and an IRIS-80 "matrix" computer with simultaneously operating processors have been selected for simulation of supersonic flight, the WARHED package of applicable programs having been written for a comprehensive analysis of the problem. References 20: all Russian.

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UDC 533.6.08

REMOTE MEASUREMENT OF AEROSOL STREAM VELOCITY WITH CONTINUOUS-WAVE CO_2-LASER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 27, No 6, Nov-Dec 86 (manuscript received 14 Aug 85) pp 39-43

[Article by V. I. Bersenev, V. M. Gordiyenko, N. N. Kurochkin, A. V. Priyezzhev, and Yu. Ya. Putivskiy, Department of General Physics and Wave Processes]

[Abstract] A medium-range Doppler laser instrument is considered for remote velocity measurements in the atmosphere. Its basic component is a probing continuous-wave single-frequency CO_2-laser with an NaCl-plate beam splitter and a focusing lens. It includes an aligning He-Ne laser, an attenuator, another NaCl-plate beam splitter, a power meter, and a spectrum analyzer preceded by another focusing lens, a square-law photodetector-mixer, and an amplifier. Better reliability of measurements with better signal characteristics and possibility of data storage are provided by conversion of analog signals from the spectrum analyzer into digital ones and processing the latter by a CAMAC crate with an Elektronika-60 microcomputer and flexible magnetic disks. The instrument operates according to the Doppler principle, with a difference signal produced by heterodyning and mixing. A laboratory prototype was calibrated on a rotating disk over the 0.15-15 m/s velocity range corresponding to a 0.03-3 MHz range of Doppler difference frequency. It was then used experimentally, with a GeAu-photoresistor detector (sensitivity threshold 10^{-15} W/Hz) or with a HgCdTe-photodiode detector (sensitivity threshold 10^{-19} W/Hz) for measuring the velocity of aerosol streams from distances of 0.3-1 km. Its performance was improved after replacement of the focusing lens with a reflecting telescope. Figures 2; references 12: 5 Russian, 7 Western.

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UDC 541.2+548.4

RESTRUCTURIZATION OF ATOMIC CONDENSED STATE UNDER STRONG EXTERNAL INFLUENCING ACTION

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 1, Jan 87 pp 82-121

[Article by A. I. Olemskiy and V. A. Petrunin, Institute of Strength Physics and Materialogy, Siberian Department, USSR Academy of Sciences, Tomsk branch]

[Abstract] Restructurization of the atomic condensed state under strong external influencing action is analyzed theoretically, first being considered the effect of a strong external field. The theory of attendant structural transformations classifies them into displacement transitions and order-disorder transitions. Next restructurization of the spectrum of collective excitations is considered, with temperature-dependent restructurization of the dispersion law for phonons and, at higher temperatures, increasingly significant diffusion. A laser model with a one-particle potential of atoms has been proposed explaining restructurization of the condensed state. Displacement transitions correspond here to a one-particle potential with one well and can occur when the order parameter corresponds to a reactive mode, while order-disorder transitions correspond here to a one-particle potential with two wells and can occur when the order parameter corresponds to a relaxation mode. Restructurization of an atomic system is then examined in the Green representation so that interatomic interaction as well as interaction of atoms and the collective mode in a homogeneous system can be taken into account. A field theory is subsequently constructed for the viscoelastic behavior of a condensed medium. Displacements of atoms in a highly excited crystal are evaluated, disregarding quantum effects but without resorting to the adiabatic approximation hardly applicable to highly excited states. Calculations are based on modeling the restructurization of the potential profile as a whole. Next is constructed a field theory of plastic flow, plasticity of real solids being attributable to evolution of the ensemble of defects in the crystal structure, whereupon a field theory of defects in a crystal structure is constructed. There follows a microscale treatment of crack formation in solids on this basis. Of special interest is martensite transformation, a microscopic theory of phase transitions based on the laser model and the appropriate synergy diagram being evidently adequate here. Transition of a liquid to an amorphous state, its vitrification, can also be explained on the basis of a synergy theory, but only with concurrent accounting for restructurization of the atomic system and of the collective mode. Figures 9; references 57: 33 Russian, 24 Western (17 in Russian translation).

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UDC 669.14.018.252.3:621.046.537.534.9

MODIFICATION OF PROPERTIES OF METALS BY HIGH-POWER ION BEAMS

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 1, Jan 87 pp 52-65

[Article by A. D. Pogrebnyak, G. Ye. Remnev, S. A. Chistyakov and A. Ye. Ligachev, Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute imeni S. M. Kirov]

[Abstract] Progress in development of high-power ion beams for treatment and forming of metals and alloys through modification of their properties is reviewed analytically, for a comparative evaluation of this technology relative to conventional ones. Sources of high-power ion beams are described, the basic device being a magnetically isolated diode variously designed and optimized to meet specific requirements. Production of 400 keV ion beams with currents up to 4 kA in pulses of typically 60 ns duration, yielding a current density of 150-250 A/cm^2, is already feasible. Modification of physicomechanical and chemical properties of the target material by such ion beams is studied and monitored by high sensitive Auger-electron spectroscopy and secondary-ion mass-spectroscopy, also by annihilation of positrons, by Rutherford backscattering of channeled ions, and by Mössbauer spectrum measurements. Modifiable properties of most concern include wear resistance and corrosion resistance. The effect of ion bombardment on these properties of carbon and alloy steels, aluminum, and tungstenless titanium alloys (Ti-Ni, Ti-Ni-Co) are compared with that of conventional machining with cutters. A model is proposed which explains this effect of a high-power ion beam on a metal in terms of three successive stages: 1) intense heating with depthwise diffusion of heat, 2) transition to vapor-plasma state by the gas-dynamic dispersal mechanism, 3) restructurization of the surface layer upon fast cooling in the wake of an ion-current pulse. Another important process stimulated by action of a high-power ion beam is formation of carbides upon ionic mixing of the host metal and alloying elements with the carbon-rich adsorbed film. An outstanding feature of the ion-beam technology is the possibility of selecting the kind of ion, namely the element whose ions are most suitable for a specific application, and regulating the ion energy. Another important feature is that alloying and annealing can be combined in a single operation. The authors thank A. N. Didenko for support and general guidance, also I. F. Isakov, S. A. Pechenkin, Sh. M. Ruzimov, L. N. Puchkareva, S. V. Plotnikov, and others for assistance. Figures 11; tables 2; references 39: 29 Russian, 10 Western.

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NEW BRANCH OF SOLID-STATE PHYSICS

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 1, Jan 87 pp 3-8

[Article by V. Ye. Panin, professor, corresponding member, USSR Academy of Sciences]

[Abstract] Research in solid-state physics branched out in a new direction, concerning highly excited states in crystals, upon publication of the article "Atom-Vacancy States in Crystals" by V. Ye. Panin, V. Ye. Yegorushkin, Yu. A. Khon and T. F. Yelsukova in IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA Vol 25, No 12, 1982. Perturbation theory and translational symmetry not being applicable here, new concepts had to be developed. Any distortion of the crystal structure must be treated not simply as a defect but as an allowed state genetically latent within the electron energy spectrum of a crystal. Five articles on the subject appear in this Vol 30, No 1, 1987 issue of IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA. The first article, "Highly Excited States in Crystals" by V. Ye. Yegorushkin, V. Ye. Panin, Ye. V. Savushkin and Yu. A. Khon deals with the interrelation between electronic and vibrational excitations and configurational excitations, with microscale ordering kinetics, with dissipative structures and atom-vacancy states, with the effect of highly excited states on martensite transformations, surface reconstruction, and properties of amorphous metals, with anomalous mass transfer, and with fast mechanical processes in solids. The second article, "Spectrum of Excited States and Vortical Mechanical Field in Deformed Crystal" by V. Ye. Panin, Yu. V. Grinyayev, V. Ye. Yegorushkin, I. L. Bukhbinder and S. N. Kulkov, deals with plastic deformation of a crystal as a process of structural transformation within ranges of highly excited states and their relaxation accompanied by formation of defects as elements of the new structure, and with appearance of a mechanical field in a deformed single crystal in a structurally nonhomogeneous medium characterized by strain levels, and in a crystal during structural phase transition. It also reports on experimental studies pertaining to a mechanical field in a deformed crystal. The third article, "Modification of Properties of Metals by High-Power Ion Beams" by A. D. Pogrebnyak, G. Ye. Remnev, S. A. Chistyakov and A. Ye. Ligachev, deals with sources of high-power ion beams, with changes produced by such beams in physicomechanical and chemical properties of metals, and with a proposed model explaining action of a high-power ion beam on a metal. The fourth article, "Anomalous Hall Effect in Disordered Ferromagnetic Alloys of Transition Metals" by A. V. Vedyayev, A. N. Voloshinskiy, A. B. Granvoskiy, and N. V. Ryzhanova, deals with basic types of spin-orbital interaction responsible for the anomalous Hall effect, with qualitative theories of the anomalous Hall effect in alloys based on solution of the equation of kinetics, with the anomalous Hall effect in amorphous alloys and in Kondo systems, with the coherent-potential approximation relative to the anomalous Hall effect, and with the anomalous Hall effect at high temperatures. The fifth article, "Restructurization of Atomic Condensed State Under Strong External Influencing Action" by A. I. Olemskiy and V. A. Petrunin, deals with restructurization of atomic states in strong external fields, with restructurization of the spectrum of collective excitations, with the laser model of restructurization of the condensed state, with a field theory of viscoelastic behavior of a condensed medium, with atomic displacements in highly excited

crystals, with a field theory of plastic flow, with a field theory of defects in a crystal structure, with a microscale treatment of crack formation in solids, with a microscopic theory of martensite transformation, and with a synergy theory of vitrification of liquids. References 6: 5 Russian, 1 Western.

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ANOMALOUS ELECTRICAL RESISTANCE OF AMORPHOUS $Re_xTa_yH_{100-x-y}$ FILMS AT SUPERCONDUCTING TRANSITION IN MAGNETIC FIELD

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 3, 10 Feb 87 (manuscript received 9 Nov 86) pp 134-136

[Article by I. V. Zolotukhin, V. M. Fedorov, V. S. Zheleznyy and Yu. V. Barmin, Voronezh Polytechnic Institute]

[Abstract] For an experimental study of amorphous $Re_xTa_yH_{100-x-y}$ films and their superconducting transition in a magnetic field, 5-10 μm thick films of $Re_xTa_9H_{91-x}$ (x = 84, 83, 81, 79, 77) were produced by ion-plasma sputtering of Re and Ta with subsequent hydrogenation. Their composition was monitored by X-ray, Auger-electron, and photo-electron spectroscopy, their structure was examined by the X-ray diffraction method. Their electrical resistance in a transverse 12 kOe strong magnetic field of superconducting solenois was measured at temperatures covering the 4.2-300 K range, with the measuring current less than 50 μA. The results reveal that the electrical resistance of films containing 7-14 atom.% H_2 peaks at a temperature near the transition point and remains almost equally low at all other temperatures. The magnitude of this effect depends on the film composition, being largest for a $Re_{81}Ta_9H_{10}$ film ($\Delta R/R$ = 126). As the magnetic field intensity is increased, the peak of electrical resistance shifts toward lower temperatures with less than 0.05 K hysteresis. Accordingly, the superconducting transition temperature can be determined on the basis of maximum electrical resistance. A theoretical analysis of the data, taking into account the density of electronic states on the Fermi surface with negligible electron-phonon interaction, indicates that the cause of this anomalous increase of electrical resistance is suppression of superconductivity by formation of covalent pairs in a magnetic field. Figures 2; tables 1; references 5: 3 Russian, 2 Western.

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MAGNETOELECTRIC WAVES

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 2 Oct 86) pp 127-129

[Article by E. L. Nagayev, All-Union Scientific Research Institute of Current Sources]

[Abstract] The reverse magnetoelectric effect in ferromagnetic crystals in an alternating magnetic field is analyzed, a nonuniform periodically alternating magnetic field parallel to the magnetic moment generating magnetoelectric waves with the electric field vector parallel to the wave vector. This effect is demonstrated theoretically for a crystal of a ferromagnetic semiconductor material. Calculations begin with the energy in the principal 1/S-order (S - magnitude of f-spin) and the force acting on an electron in such a field where s-f exchange occurs, considering that the electric current is proportional to the gradient of the electrochemical electron potential and after the dependence of this potential on the magnetic field intensity has been established. The frequency of the magnetic field is assumed to be sufficiently low for negligible eddy currents and skin effect. The magnetoelectric effect is then also shown to occur in the case of an alternating magnetic field distorted by the skin effect. References 2: Russian.

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SELECTIVE ABSORPTION OF RADIOACTIVE Sr AND Cs DURING FORMATION OF MONTMORILLONITIC GELS

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 15 Dec 86) pp 146-149

[Article by A. A. Vedenov, Ye. B. Levchenko, G. D. Mylnikov and Yu. M. Senatorov, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] Gelation of betonite, a montmorillonite variety from the Cherkassy deposit (UkSSR), after conversion into Na-clay was studied concerning replacement of Na^+ ions by Cs^+, Ca^{2+}, Sr^{2+} ions during sedimentation and compaction from suspension in distilled water in the presence of those ions. The reduction of the gel layer thickness by sagging of its upper surface under a building up layer of transparent solution was measured as a function of time till the thickness began to stabilize after approximately 14 h. The amount of sag and the collective diffusion coefficient were found to increase with increasing NaCl concentration over the 0.1-0.7 mol.% range. Theoretical analysis and calculations based on the model of such a gel as a one-dimensional mass-spring system of N particles indicate a selective absorption of Cs^+, Ca^{2+}, Sr^{2+} ions replacing Na^+ ions and confirm that sedimentation occurs faster as the concentration of Cs^+, Ca^{2+}, Sr^{2+} ions is increased. The authors thank L. I. Tretyakova, A. F. Usaty, V. I. Finko and A. A. Khrulev for collaboration. Figures 2; references 14: 1 Russian, 13 Western (2 in Russian translation).

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ENTRAPMENT OF QUANTUM PARTICLE IN SHALLOW POTENTIAL WELL AND FORMATION OF SOLITON FROM CLUSTER OF LANGMUIR WAVES

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 6(12), Dec 86 (manuscript received 14 Jan 86) pp 2039-2052

[Article by V. T. Astrelin, B. N. Breyzman and V. V. Vasilyev, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences, Z. Sedlacek and K. Jungwirth, Institute of Plasma Physics, Czechoslovak Academy of Sciences]

[Abstract] Formation of a soliton in a plasma with strong Langmuir turbulence is analyzed theoretically, the mechanism of this phenomenon being deformation of the plasma density profile under the pressure of Langmuir waves with attendant entrapment of some waves in a low-density well into a self-sustained bound state. The process is described by a system of two equations for the plasma density perturbation and the high-frequency electric field with complex amplitude. The problem has already been solved for the extreme case of Langmuir waves with low group velocity and consequently low energy, when the plasma density perturbation instantaneously conforms to the distribution of high-frequency pressure and the two equations are reducible to a nonlinear Schrödinger equation which can be integrated by the "inverse scattering" method. In the general case this is not possible and instead a small parameter is extracted, assuming zero initial plasma density and its rate of change in an electric field initially distributed within a cluster of a width λ much smaller than the apparent Debye radius $r_D(M/m)^{1/2}$ (m - mass of ion, m - mass of electron). Their ratio, more precisely two thirds of it, serves as the small parameter. A shallow potential well is considered, its depth varying as a power function of time and in the simplest case linearly with time. Fundamental relations are derived for entrapment of plasmons constituting the electric field cluster, the number of entrapped plasmons depending on the initial cluster width and energy. Depending on the number of plasmons in the original cluster, relative to that small parameter, the dynamics of soliton formation will, according to the proposed model, involve different sequences of processes: inertial entrapment of plasmons followed by their adiabatic compression and then by similar compression of the well when that number is large or by their acoustic compression when that number is smaller, or inertial deepening of the well without entrapment of plasmons followed by their acoustic entrapment and then their adiabatic compression when that number is small. The analytical solution was checked against numerical integration of the fundamental equations, with the small parameter set equal to 0.125 and assuming a

Gaussian initial electric field distribution, for determining both ways the dependence of the number of plasmons in the soliton on the number of plasmons in the original cluster. The proposed model does not apply to very small and very large numbers of plasmons in the original cluster, a nonlinear Schrodinger equation then partly describing the process and complete transition of plasmons into the bound state with possible formation of several solitons occurring in the latter case. Figures 4; references 8: 4 Russian, 1 Hungarian, 3 Western (1 in Russian translation).

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MEAN MULTIPLICITY AT HIGH ENERGY

Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSR: SERIYA FIZIKO-MATEMATICHESKAYA in Russian No 6(133), Nov-Dec 86 (manuscript received 30 Jan 86) pp 48-51

[Article by I. G. Golyak and Zh. S. Takibayev, Institute of High-Energy Physics, KaSSR Academy of Sciences, Alma-Ata]

[Abstract] A multiplicity of charged secondary particles in a high-energy hadron-hadron interaction is calculated on the basis of Heisenberg's uncertainty principle, this principle following from the commutation relations (p,q) in quantum mechanics and being characterized by an energy dependence. Inelastic hadron-hadron interaction is considered, with Gaussian representation of the scaling-invariant structural function $\varphi(x,P_\perp^2)$ in the differential cross-section for an inclusive reaction. The resulting expressions describe experimental data obtained with s up to $5\cdot10^2$ GeV^2 and $\langle P_\perp^2\rangle$ = const = 0.33 (GeV/s)^2, the mean multiplicity also increasing logarithmically with s just as the cross-section does. Accordingly it approaches the asymptotic value $\langle n_{ch}\rangle_{s\to\infty} = A + Be^{Q\sqrt{\log s/\Lambda^2}}$, the same as according to one variant of the quantum chromodynamics theory. References 16: 4 Russian, 12 Western (2 in Russian translation).

2415/5915
CSO: 1862/125

EXISTENCE OF ABSOLUTELY CLOSED UNIVERSE

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 2, 25 Jan 87 (manuscript received 4 Dec 86) pp 61-64

[Article by M. A. Markov, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] The mass within the spherical layer by which a closed isotropic Universe expands to its maximum radius is calculated according to classical mechanics and the Landau-Lifshits field theory (1973). This mass is found to be universal and independent of the Universe's "bare" mass, which satisfies the pertinent general fundamental theorem. The imprecision of determining the maximum radius and thus also the volume of that spherical layer is accounted for. An analysis of the result in the light of concepts such as "gray holes" (Ya. V. Zeldovich and I. D. Novikov, 1971), "black holes of the second kind" (M. A. Markov, 1974), and "maximon clusters" (M. A. Markov, 1981) leads to the conclusions that the Universe cannot be absolutely closed and cannot evolve from "nothing", also that a black hole of second kind can be stable and have a mass of the order of a maximon mass but cannot evolve from simple collapse of stars. References 11: 9 Russian, 2 Western.

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'MAXIMON' AND 'MINIMON' AS 'ELEMENTARY PARTICLES' IN POSSIBLE FORMULATION OF THAT CONCEPT

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 3, 10 Feb 87 (manuscript received 16 Dec 86) pp 115-117

[Article by M. A. Markov, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] The possibility of physically justifying generalization of all "elementary particles" in the CERN list on the basis of some common parameters is discussed, two such parameters being identified applicable to any particle which has a mass m whether microscopic or macroscopic with any internal structure. They are the gravitational radius R_g and the Compton length L_c, both related to the mass through the speed of light c, the former also through the gravitational constant k and the latter also through the Planck constant $\hbar$ and still another constant α. The constraint $L_c \geq R_g$ limits the mass spectrum of particles so that one of maximum mass and one of minimum mass should exist. The mass of each can be evaluated numerically, if the value of constant α is known. That constraint and the additional constraint $L_c > L_r$, where L_r is a structural dimension of a particle not directly expressible through world constants but determined by fundamental interaction of constituent particles, can exclude from the list particles composed of nucleons such as a deuteron or a proton depending on the magnitude of constant α. Meanwhile a "black hole" has the properties of a maximon and a neutrino is actually a minimon. References 4: 2 Russian, 2 Western.

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